

ISSN: 1987-6521; E-ISSN:2346-7541, DOI prefix: 10.36962

JULY 2019 VOLUME 48 ISSUE 05

GULUSTAN

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SCIENTIFIC JOURNAL OF ACADEMIC RESEARCH

MULTIDISCIPLINARY JOURNAL  
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ISSN: 1987-6521; E-ISSN:2346-7541, DOI prefix: 10.36962

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Index Copernicus Value (ICV) for 2018 – 76.92

IPI Value: 2.42

IARC Impact Factor 2017 – 2.110

Catalogue of Russian Journals Impact Factor (2016) – 0.171

Impact factor ПИИЦ 2017-0.041

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ISSN: 1987-6521; E-ISSN: 2346 – 7541; UDC: 551.46 (051.4) / B-64

©**Publisher:** LTD International Research, Education & Training Center. (UK, London),

**Director and shareholder:** Alexandra Cuco. Lawyer. Portugal.

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**Registered address:** 71-75 Shelton Street, Covent Garden, London, WC2H 9JQ, UK.

**Telephones:** +994 55 241 70 12; +994 51 864 88 94

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## CONTROL OF QUALITY AS AN IMPORTANT TOOL FOR DEVELOPMENT OF INTERNAL CONTROL

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### ABSTRACT

Development of internal controls is a highly important issue for the organization, especially for public institutions, because internal control system creates mechanism to effectively utilize human, financial and time resources. Public institutions are characterized by various risks, such as: uneconomic and unreasonable spending of budget funds, corruption, fraud and so on. In order to reduce these and other risks, it is important that organizations have an effective system of internal control. The internal control system in the public sector is regulated by the relevant legislation and standards, which determines that internal control includes: Financial management and control system. Functionally independent internal audit and Harmonization Center. Each of them is an integral part of internal control. Their independence is the prerequisite for the existence of an effective system. The article presents results of our research carried out by the internal audit benefit and quality.

**Keywords:** Quality, Internal control, Internal audit, Efficiency, Risk, Development.

### INTRODUCTION

Control is an integral part of the management of economic objects and processes. It is to observe objects in order to check whether the condition of the object corresponds to a desirable and necessary condition, envisaged by laws, statutory legislative acts, plans, instructions, provisions, resolutions and other subordinate acts. Control is a necessary and final stage for any decision-making process. It is recognized as a method that ensures the implementation of the goals set by management structures, determining the direction of improving the use of economic resources, deficiencies and disorders and correction of their results.

By introducing the internal control system, the organization provides risk management and thus achieving the goals set. On the other hand, it is manifested in the effective, efficient and observational performance of the institution. At the same time, it is aimed at ensuring the assurance of attaining the goals set before the organization.

### Body part

Control is an independent function through which is checked the compliance of functionality of the object and its corresponding decisions. Control measures are effective if it is:

- Appropriate;
- Consequently implementable;
- Perfect;
- Cost-effective efficiency;
- Directly connected to the control objectives.

In turn, the role of internal control in the public sector is crucial. Due to the fact that the resources in the public sector are created based on public money and therefore they should be used in accordance with public interests. Control of the acquisition, use and protection of resources in the public sector is very important.

As noted above, the internal audit is an integral part of the internal control system, which represents independent, objective and advisory activities aimed at improving the activities of the institution, achieving its objectives and fulfilling its objectives. It assesses the systematic, disciplined and organized approach and improves the effectiveness of risk management, control and management processes. The Internal Audit assesses the financial management and control system, the effectiveness of risk management and issues recommendations for their improvement.

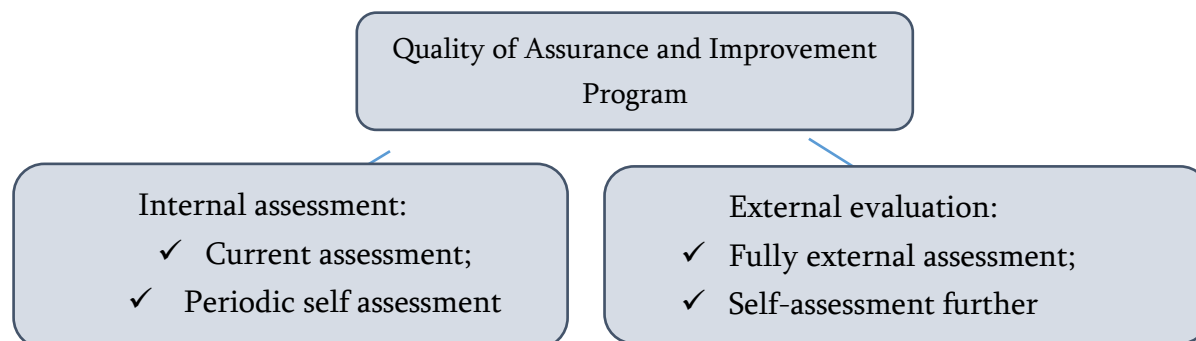
Evaluation of the internal control system is important and at the same time a difficult issue. Basically its benefits and efficiency are more visible in the longer term, since its benefits are not always expressed in the index. In addition, the effect of effective internal control system is often revealed in the long term. It should also be noted that control of quality is important in the assessment of the benefit of internal control.

There is standard / reference - 1300 – Quality of Assurance and Improvement Program, according to which the Audit Manager should develop and implement a Quality of Assurance and Improvement Program that includes all aspects of

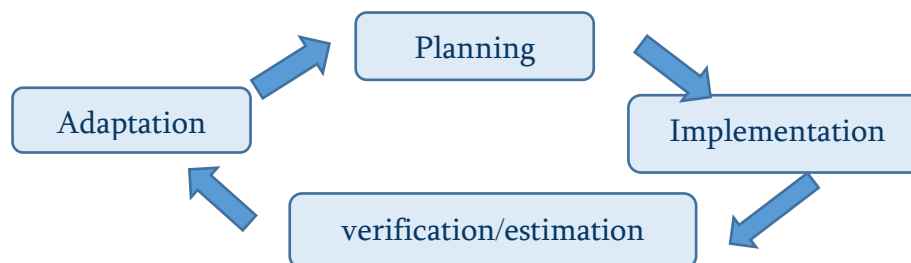
internal audit activities. The main objective of the program is to assess the compliance of the internal audit subject with the Code of Ethics, the internal audit definition, standards and other regulatory norms. Eventually, quality management should be an integral part of internal audit activity, which is carried out at all stages of audit. The Quality of Assurance and Improvement Program will consist of internal and external evaluation (see Schedule N1).

#### Schedule N1

#### Quality of Assurance and Improvement Program



It is important that in the budget institutions there is a current monitoring system that consists of the following stages:



The above is a part of the Quality of Assurance and Improvement Program and is an ongoing monitoring of the quality control cycle stages.

As for external evaluation, standard / reference - 1312 - "external evaluation" explains that external evaluations should be carried out at least once every five years by a qualified independent columnist or reviewer group.

Also, it is important to note that in the budgetary institutions, the reporting phase should be based on the Standard / Reference - 1320 - "Report of Quality Assurance and Improvement Program Results". This standard implies that the audit's head must submit to the higher management and board the information on the results of the Quality Assurance and Improvement Program.

We conducted a qualitative research conducted in public institutions, in the format of in-depth interviews. In addition to the need for internal audit internal quality control, research shows that its significance is due to other factors, namely that the ongoing processes in the organization are constantly changing and dependent on legislative amendments, international commitments, challenges in the country, public intelligence Resources, new approaches, etc. Consequently, the internal audit needs constant improvement and quality assurance, which quality control can provide. It is interesting to note that in some cases the respondents direct attention to have certain steps in organization. It should also be noted that the quality control at the legislative level are linked to additional financial resources, so this is a obstructive circumstance. Some respondents said that they have developed quality control elements, such as, each of the final report and recommendations are reviewed by the head of internal audit, individual monitoring, the comments after receiving each audit, risk analysis and the annual rate of annual planning for improvement.

## CONCLUSION

The research enabled us to make conclusions about the needs, challenges and quality of development in the internal control system.

The development of a state internal control system constitutes a continuous process, it requires constant improvement, while internal control is the main leverage for managing and minimizing risks in public institutions. Consequently, the benefit of the introduction of internal control will be reflected not only in the savings of financial resources, but also in the efficient expenditure of the economy, but also in improving processes / procedures, managerial accountability, efficient and productive achievement of goals and correct distribution of responsibilities. Quality of control has own influence on all of this, since it is based on its introduction and development of effective control of the control system.

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## DESIGN, DEVELOPMENT AND CONSTRUCTION OF A MEDICAL WRIST REHABILITATION DEVICE

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### ABSTRACT

The research and development of new kinds of technologies to support the recovery of human injuries have orientated the design, development and construction of new devices for the treatment and rehabilitation of wrist injuries. With limited funds, the construction of a new prototype was carried out with off-the-shelf components. After a detailed research and design work, the obtained device can be divided into two main components: it is capable to provide an adequate rehabilitation of the wrist and adequate proprioception exercises, allowing the patient to relax and to decrease the focus of pain.

The development and construction of the device upholds the idea of portability, multifunctional operation and special designed hardware and software control, so it can be simple and user-friendly, allowing the control over the progress of rehabilitation with data recording for later analysis by physiotherapists and/or patients without any special training. The mentioned multifunctional operation, low-cost, user-friendly and portability makes it a good choice when compared to other complex robotic rehabilitation devices.

This paper will present, discuss and analyse the proposed portable device, as well as its ability for the purpose of wrist rehabilitation.

**Keywords** — Biomechanics; Wrist; Rehabilitation; Proprioception; Arduino

### INTRODUCTION

For the purpose of wrist rehabilitation, it is important to have a clear knowledge about all the natural capabilities of the upper member. The wrist is therefore one of the most fundamental members of the human body, with complex associated movements that can be divided into 3 groups: pronation/supination, adduction/abduction and flexion/extension. Fracture of the wrist is one of the most complicated pathologies. This type of injury has a large incidence in adulthood, and occurs mostly in women, since osteoporosis increases the brittleness of bones, and, as such, in case of impact there is a great susceptibility to bone breakage. In relation to the younger individuals, this type of fracture is mainly due to sports injuries [1].

A new device, totally oriented to this kind of problems, could make the recovery of patients more comfortable and easier. The authors of this study have teamed up with health and rehabilitation specialists in order to design and develop the best possible device to help and minimize the recovery time and pain during the rehabilitation of patients. All these topics will be analysed over the next sections, the design and development stages will be considered, and the analysis of the results and conclusions obtained so far during the test phases of the device will be included.

### The Rehabilitation Device

A previous analysis carried out before starting the development of this new type of device showed that almost all the existing prototypes follow just a unique purpose. They all focus on just one of the 3 groups of movements of the wrist and all use an ergonomic cylindrical joystick, where the patient places his/her hand. After a previous research about the hand/wrist complex, it was determined that the spherical form is the more ergonomic form for the purposes of hand or wrist rehabilitation, with a diameter close to the diameter of a tennis ball. This project began with the use and adaptation of an existing product named Powerball, which was designed to perform fitness exercises on the wrist, forearm and shoulder. Through the modification of this product, a new rehabilitation device named BioBall was then created (see Fig. 1).



Fig. 1 - The new designed and developed rehabilitation device named BioBall.

To control the device's movements, an internal controller board was setup with specially designed algorithms to control, by software and hardware, the two electrical motors inside the device's structure and inside the rehabilitation ball respectively. Inside the structure it has been assembled a Superior Electric M062-LE04 stepper motor, NEMA 23 [2], which was controlled through a TB6600 driver that also powered the motor. Fig. 2 shows the electronic control schematic circuit.

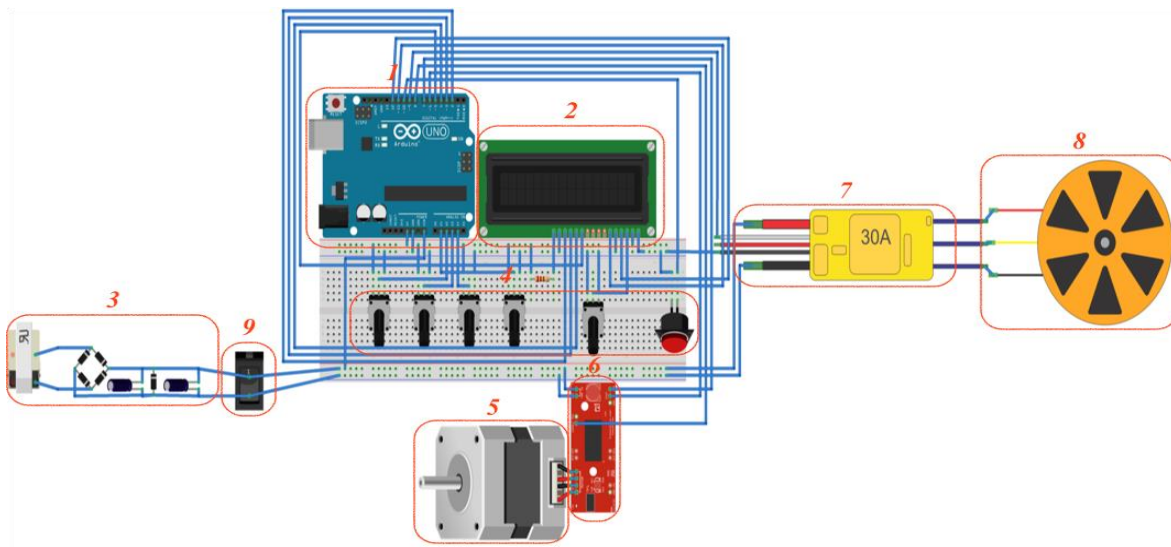


Fig. 2 - Electronic schematic circuit of the device control: 1) Controller Board; 2) LCD 16X2; 3) Power Supply; 4) Control Interface; 5) Stepper Motor; 6) Stepper Motor Driver; 7) ESC; 8) Servo Motor; 9) Power Button.

It is possible to make speed, angle and program adjustments using physical buttons on the front panel of the device or using a graphical interface that has been designed in LabVIEW (by National InstrumentsTM) [3]. Fig. 3 depicts the friendly graphical interface developed in LabVIEW.

When coupling the motor to an eccentric bar, the rotation of the stepper motor promotes a dislocation of the ball that is grabbed by the hand. This dislocation allows the wrist to simulate its natural movements and it can be adjusted to people with different hands sizes. Combining the different position adjustments of the support, the device enables the reproduction of the natural movements associated with the wrist of the patient.

The specific designed and prototyped hardware and software for this purpose allows the control of both motors and respective drivers, using an Arduino development board.

Due to the fact that these types of devices are only focused on developing one unique movement, this new device is addressed to develop all the needed movements for the complete rehabilitation of the wrist. The development of the multifunctional device was divided into two main subsystems: the one for rehabilitation purposes, through the reproduction of the wrist movements, and the second one for vibration therapy, proprioception and relaxation sessions.

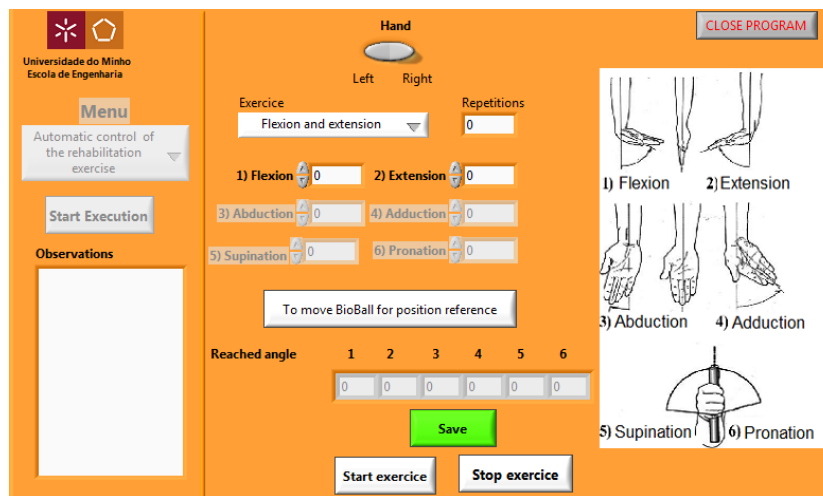


Fig. 3 - The friendly human-machine interface (HMI) developed in LabVIEW (by National Instruments™).

### Rehabilitation of the movements of the wrist

The rehabilitation procedure is focused on the principal movements of the wrist and following the instructions of health specialists in rehabilitation, the device was developed and validated by physiotherapists at the Hospital of Braga, in Portugal, based on their own experience in the rehabilitation of patients with wrist pathologies [4]. As mentioned, the main movements of the wrist are flexion, extension, adduction, abduction, pronation and supination, and all these movements have maximum admissible angles that depends on the person's health. Table 1 identifies the angles associated with each one of the movements of a healthy wrist [5] and Fig. 4 allows a better understanding of the movements and maximum admissible angles associated with the wrist.

This new device also enables two different rehabilitation subsystems: 1) Active rehabilitation and 2) Passive rehabilitation. For active rehabilitation, the user creates some resistance to the movement generated by the motor inside the device, exercising therefore the muscles of the hand, wrist and forearm. For passive rehabilitation, the patient grabs the ball and the device helps the patient to perform each one of the exercises. If the movements' amplitude is big and/or the patient feels some pain during the procedure, he/she simply releases the ball. For pathologies like broken wrists or fingers, or any other kind of chirurgic recoveries, the passive rehabilitation mode must be selected.

Table 1 - Associated angles to each one of the movements of a healthy wrist [5].

Movement type	Associated angle
Flexion	85°
Extension	85°
Adduction	45°
Abduction	15°

Pronation	75°
Supination	85°

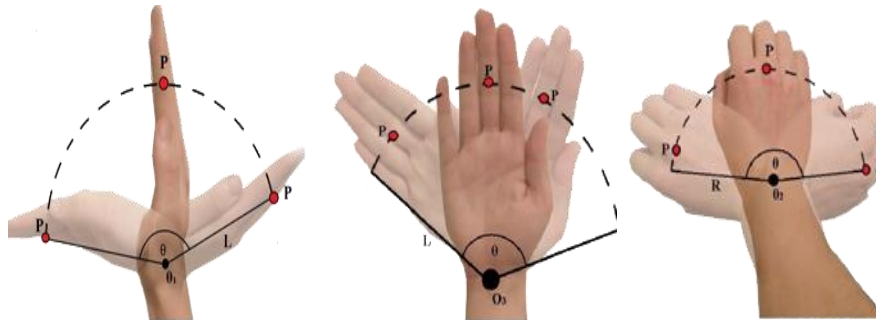


Fig. 4 - Wrist movements' reproduction (from left to right: Flexion/Extension; Adduction/Abduction, and Pronation/Supination).

Due to the fact that the angle and speed are adjusted by the physiotherapist or the patient, the device is adjusted to every step of the rehabilitation process. The increments of the amplitude of the angle associated with the rehabilitation process are the ones related with a healthy wrist. Since there are limited angles to each one of the movements of the wrist, the adjustments must be tuned with the correct amplitude of angle and speed for each patient. To ensure the patient's security during each session, the device must be tuned to lower speeds of rotation of about 1.88 rpm, and, to prevent maximum velocities, the device was setup to enable a maximum speed of 10 rpm. This device also records all the information regarding the rehabilitation exercises and the physiotherapist can evaluate the recovery of the patient and carry out a precise follow up of all the rehabilitation sessions.

#### Vibration, therapy, proprioception and relaxation sessions

Vibration therapies have been the main focus of recent research as an important method for wrist rehabilitation [6]. This device can reach an operation frequency of about 150 Hz and, changing the amplitude of the vibration by modifying the eccentric mass coupled to the motor, it can also be used for new recovery treatments.

It is possible to promote the relaxation of affected regions through the use low vibrations between 30 and 50 Hz, to ensure the well-being of the patient [7] [8] [9]. For the physiotherapist, the easy handle of the ball on the device can also provide a relaxation session therapy to patients.

Depending on the type of injury or intervention, sometimes the patient loses some sensibility, which also might affect the ability and control of the correct movements of the injured member. This could mean that the patient has his/her own proprioception capabilities reduced at the rehabilitation stage. To provide this treatment, the BioBall induces a vibration controlled by hardware and software specially designed for this purpose, which is capable to perform proprioception sessions and to evaluate the recovery of the proprioception capabilities of the patient by recording data from each one of its sessions. Figure 5 highlights the eccentric mass coupled to the brushless motor inside the ball.



Fig. 5 - Eccentric mass that causes vibration to the ball on the device.

When a patient suffers a stroke, he/she has the tendency to close the hand and sometimes it is impossible for the therapist to totally recover the position of open hand for the patient. Using a high vibration that causes the patient to open the hand (to release the ball) it might be seen as a simple and successful way to work out this type of problems.

With high frequencies, the possibility of stimulating the nervous system and to anesthetize zones of serious pain on a patient is also another target of research and development in a future version of the device. Because a nerve impulse occurs when the cell membrane at rest senses a stimulus, which causes an ion exchange through the membrane to and from the neuron, crossing the entire neuron to the brain, and, as the neuron is travelling, the membrane is depolarized and takes a fraction of a second to become polarized again. As long as the membrane does not re-polarize, the neuron is unable to transmit information. During this period, which lasts for about 1 millisecond, the responsiveness of a neuron is about 1000 pulses per second, i.e. 1000 Hz. If a zone is stimulated at a higher frequency, the neuron is unable to receive new stimuli and the brain does not communicate with this zone, hence becoming insensitive for moments, until it no longer receives stimuli and the membranes return to polarize [10].

### Operation Modes

Specifically for this device, electrical and electronic circuits, a mechanical structure and dedicated software were developed. The electrical and electronic part allows the controller to communicate with all the sensors and actuators. The communication from the controller to the software is made by a serial port, with baud rates greater than 9600 bits/s, which is a very good communication speed value for this application. On the Fig. 6 the serial input to the device is visible on the top of the case.

The hardware used to control the motors are regular potentiometers. When changing the current values, the software reads, translates and sends a command to the motors. When the instructions are sent directly from the software to the controller via serial communication, all the instructions are translated by the software to the outputs of the controller that sends the particular signal to the motor's drivers. The signals to the drivers are PWM, which enables the translation from a digital output into an analogue signal, so for the driver the input signal is interpreted as an analogue signal.





Fig. 6 - 3D view of the BioBall rehabilitation device.

The mechanical part was developed with off-the-shelf components and other reused materials. To obtain all the movements associated with the wrist, the structure was designed and developed to perform different adjustment positions of its base. These adjustments have stop limits that enables a comfortable use by different patients. It can be observed in Fig. 7 that it is possible to vary, for example, the height distance of the device of about 70 mm.

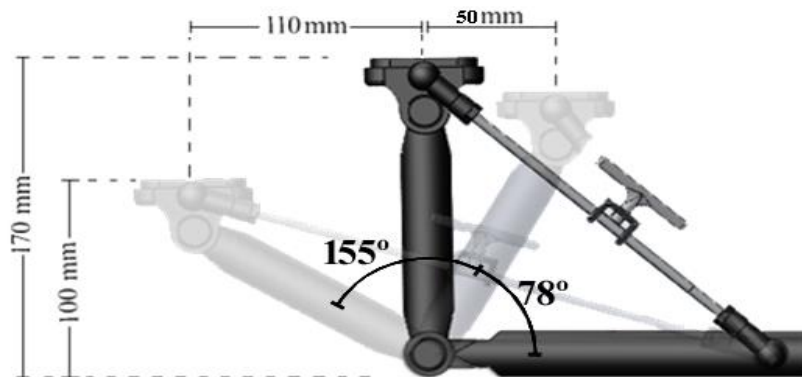


Fig. 7 - Limit adjustment positions that provide a comfortable use for different patients.

With these adjustments, and due to the fact that the top of the support has also some degrees of freedom, the device can be adjusted vertically as well as horizontally for a better and comfortable use – see again Fig. 7. The support of the device has an attachment system that provides a proper fastening and an easy assembly of the device, making it possible to place it on any table or desk.

With different grabbing positions and adjustments, the device enables the patient to grab the ball in different ways, promoting different rehabilitation exercises. Because the motor has an eccentric bar coupled to its axis, the translations of the rotation point of the hand/wrist/arm are adjusted to a more natural movement of the wrist. In Fig. 8 is possible to observe, from left to right, the 3 different groups of movements associated to the wrist: adduction/abduction, flexion/extension and pronation/supination.

Due to the nature of the pronation/supination movements, the ball should be coupled directly to the motor shaft; for this particular situation, the eccentric bar will not be used. As it can be seen in Fig. 8, the device needs to be placed horizontally for carrying out this rehabilitation exercise.



Fig. 8 - Different adjustments of the support and grabbing positions for different rehabilitation movements (from left to right: adduction/abduction, flexion/extension and pronation/supination).

The direct and indirect coupling of the ball to the motor axis placed inside the top of the device structure depends on the type of exercise to be carried out. Fig. 9 shows how the ball is coupled to the device.



Fig. 9 - Direct and indirect coupling of the ball to the device.

For each movement the patient must adjust the device structure to a natural and comfortable position, and grab the ball in a correct way, depending on the proposed exercise by the physiotherapist.

#### Results

The preliminary validation tests of the device were accomplished by physiotherapists at a rehabilitation centre and at the Hospital of Braga, both in Portugal, based on their own experience in the rehabilitation of patients with wrist pathologies. During the development stages some tests were carried out on torque analysis and power consumption. This analysis was made at different speeds where the torque/speed/power ratio was evaluated to optimize the working ranges for rehabilitation purposes.

To prevent serious damage to the recovery of the patients, the working speeds were limited to very low speeds. On active rehabilitation, the low speed is used to obtain a higher torque, as shown in Fig. 10 by the orange traced line.

The vibration exerted by the motor (for relaxation and proprioception tests and exercises) was also evaluated and, has shown in Fig. 11, the brushless motor is capable to reach about 150 Hz. This graph shows the increment of the electrical power consumption with the increase of the speed of the brushless motor, until it reaches the maximum speed.

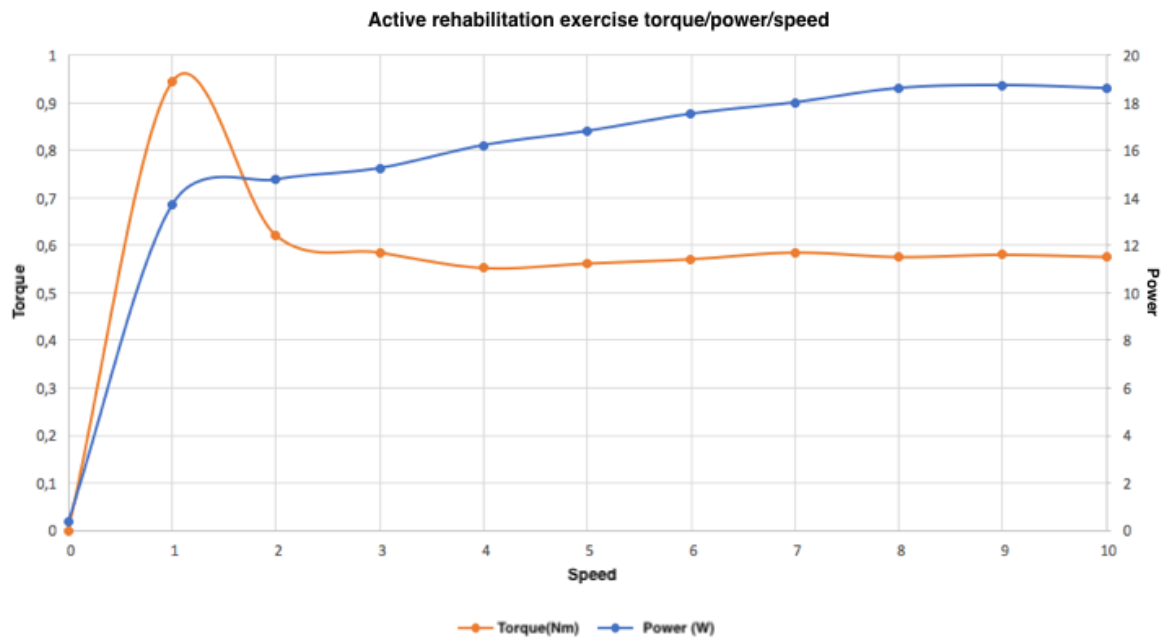


Fig. 10 - Active rehabilitation torque/speed/power ratio.

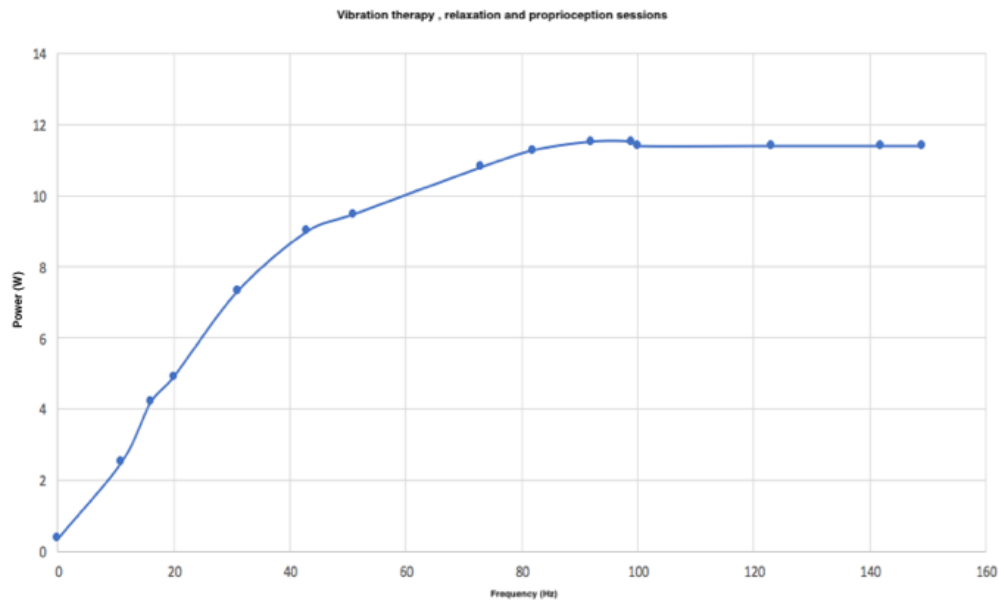


Fig. 11 - High frequency analysis of the brushless motor.

## CONCLUSIONS

The data collected by the HMI software could be sent directly to the physiotherapist through an Internet connection, so he/she can evaluate the progress of the rehabilitation after the patient finishes an exercise session. Other kinds of add-on functions can be implemented to maximise the benefit from this device.

Controlled equipments of this kind are quite large in size, do not allow any type of portability and normally are oriented to only one rehabilitation function. In addition, due to the high degree of complexity of these devices, specialized and trained operators are needed to work with these complex machines.

The design and development of the proposed device was focused on helping patients with wrist injuries or subjected to surgical interventions. This device helps patients to obtain a gain of amplitude for each group of movements associated with the wrist and also an increase of the lost force capabilities, in a practical, controlled, fast and independent way. The device is portable, easily operated and it enables the recording of all the rehabilitation progress for further/future analysis.

According to the first preliminary obtained results, this device proved its usefulness for rehabilitation purposes. Nevertheless more systematic tests are to be carried out and future work will be focused on the evaluation of the patients' recovery, with different wrist injuries, comparing this device with the traditional rehabilitation procedures.

Using more sensitive sensors for better response, for example, to safety issues and to obtain other data needed from the patients are also to be considered in future.

The overall structure of the device should be optimized for a cleaner, more friendly and appealing use by the patient; the use of non-toxic materials and others that could be easily disinfected are also to be studied, as well as the mechanical robustness of the final device and its components.

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## TIMING OF SURGICAL INTERVENTION AFTER VENTRICULAR SEPTAL RUPTURE

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### ABSTRACT

Ventricular septal rupture (VSR) is a rare but lethal complication of acute myocardial infarction (AMI). patients presenting with ST-elevation MI (STEMI) were evaluated for heart rupture (VSR) based on reperfusion strategy. After undergoing a primary percutaneous coronary intervention (PCI), VSR was reported to occur in 0.23-0.71% of patients. Post-infarction VSR carries significant mortality (36.%) despite aggressive surgical management. Rupture develops after full-thickness (transmural) infarction of the ventricular septum and can occur at any anatomic location. Ventricular septal rupture is likely to be associated with total occlusion of the infarct-related artery. the newly formed communication results in left to right shunting of oxygenated blood from the high-pressure left ventricle to the lower-pressure right ventricle. Mortality was highest in patients who underwent operation in the first 24 h, consistent with other investigators. The case reflects the important problem after myocardial infarction, ventricular septal rupture and challenges the timing of intervention. Patient 70 year old, male, caucasian was admitted in our hospital with encephalopathy and hypotension. ECG revealed ST segment elevation in II, III, AVF, V<sub>4</sub>-V<sub>6</sub> lead, ST segment depression in AVL, V<sub>1</sub>-V<sub>3</sub> lead. Koronarography detected left main artery without important stenosis, 95 % stenosis of middle segment and 75% stenosis of distal part of left anterior descending artery. 40% stenosis of middle segment of right coronary artery, occlusion of posterior descending artery. After recanalization and balloon predilatation of posterior descending artery, was performed drug eluted stent implantation. transthoracic echocardiography (TTE) detected of postinfarction VSR (pict 3). The Colour Doppler was demonstrated of flow across the septum and left to right shunt.

**Conclusion:** Ventricular septal rupture (VSR) is a rare but lethal complication of acute myocardial infarction (AMI). Mortality of patients is significantly depending on timing of surgery. Operative management of patients can be complex, and having a systematic approach is helpful. The cornerstone of medical management of VSR is afterload reduction, and may be considered routine care. According our case, surgical intervention was delayed and despite adequate treatment patient was died. There is no clear evidence to guide the surgical management of patients who are in shock, as all approaches have shown extremely high mortality. Possible strategies include emergent surgery on individuals with marked haemodynamic instability and circulatory compromise.

**Keywords:** Ventricular septal rupture (VSR), intraaortic balloon counterpulsation (IABCP), Myocardial infarction, PCI (percutaneous coronary intervention)

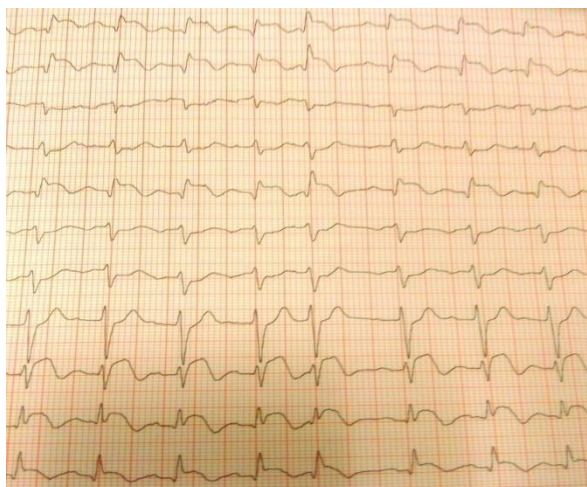
### Introduction

Ventricular septal rupture (VSR) is a rare but lethal complication of acute myocardial infarction (AMI). patients presenting with ST-elevation MI (STEMI) were evaluated for heart rupture (VSR) based on reperfusion strategy. After undergoing a primary percutaneous coronary intervention (PCI), VSR was reported to occur in 0.23-0.71% of patients. Post-infarction VSR carries significant mortality (36.%) despite aggressive surgical management. Rupture develops after full-thickness (transmural) infarction of the ventricular septum and can occur at any anatomic location. Ventricular septal rupture is likely to be associated with total occlusion of the infarct-related artery. the newly formed communication results in left to right shunting of oxygenated blood from the high-pressure left ventricle to the lower-pressure right ventricle. Mortality was highest in patients who underwent operation in the first 24 h, consistent with other investigators. The case reflects the important problem after myocardial infarction, ventricular septal rupture and challenges the timing of intervention

### Case report

Patient, 70 year old, male, caucasian was admitted in our hospital with encephalopathy and hypotension. ECG revealed ST segment elevation in II, III, AVF, V<sub>4</sub>-V<sub>6</sub> lead, ST segment depression in AVL, V<sub>1</sub>-V<sub>3</sub> lead.





Koronarography detected left main artery without important stenosis, 95 % stenosis of middle segment of and 75% stenosis of distal part of left anterior descending artery. 40% stenosis of middle segment of right coronary artery, occlusion of posterior descending artery (Pict.1)

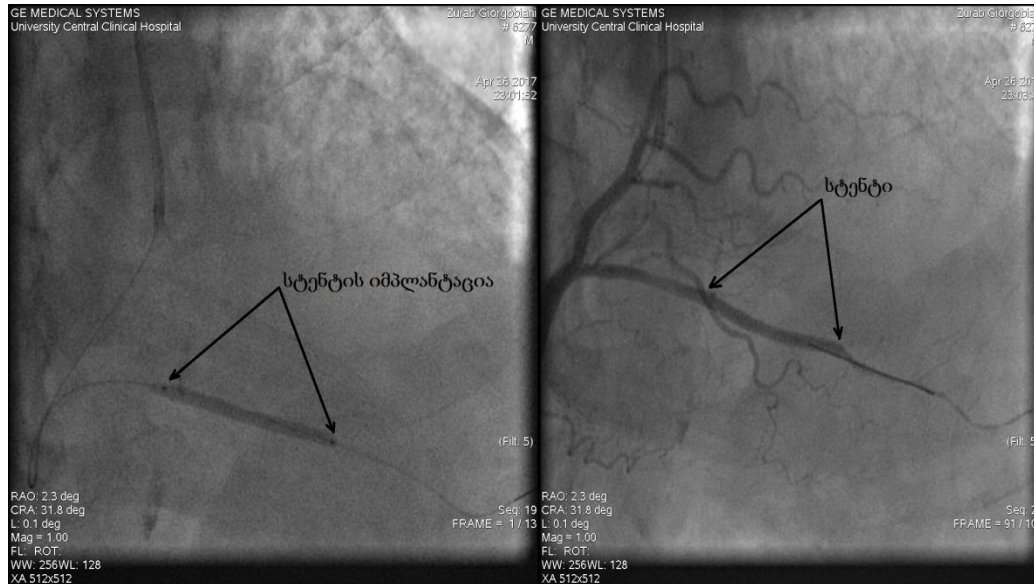


Picture 1.

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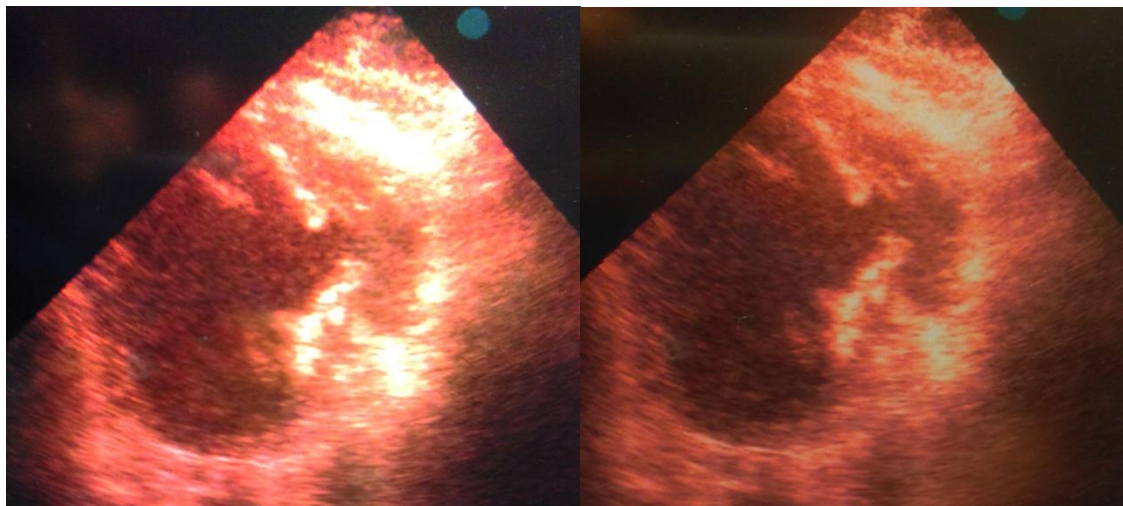
The septal blood supply comes from branches of the left anterior descending coronary artery, the posterior descending branch of the right coronary artery

After recanalization and balloon predilatation of posterior descending artery, was performed drug eluted stent implantation (promus Element Plus, Everolimus DES, Boston Scientific) (Pict 2)



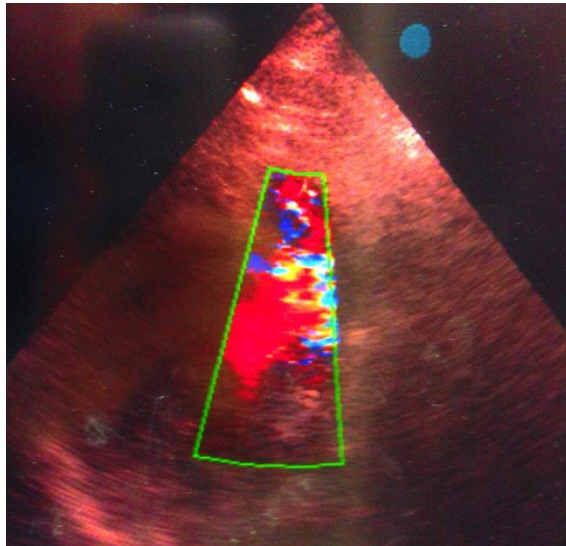
Picture 2 Stent implantation

After revascularization patient state was severe. transthoracic echocardiography (TTE) have been used to help diagnose postinfarction VSR (pict 3).



Picture 3 VSR

TTE findings have been improved with the use of color-flow Doppler methods to visualize the VSR. Usually, the diagnosis is made by a prompt transthoracic echocardiogram identifying drop-out of the ventricular septum in the 2D image and demonstration of flow across the septum using colour Doppler (pict.4)



Picture 4. Colour Doppler, flow across the septum

For hemodynamic support was used pressors infusion and intra-aortic balloon counterpulsation (IABCP). IABCP reduced left ventricular afterload, thus increasing systemic cardiac output. IABCP also facilitated diastolic augmentation with an increase in coronary blood flow, resulting in an improved oxygen supply. Surgical interventions was delayed until stabilization of patient state, but after 3 days of PCI patient was died.

**Discussion:** The median time from the onset of symptoms of acute myocardial infarction to rupture is generally one day in the GUSTO trial and 16 hours in emergently revascularized occluded coronaries in SHOCK trial. Management of the patient who is in acute, decompensated cardiogenic shock should be directed at reducing left-to-right shunt with afterload reducing agents and IABP placement. IABCP reduces left ventricular afterload, thus increasing systemic cardiac output and decreasing the Qp-to-Qs ratio. IABCP also facilitates diastolic augmentation with an increase in coronary blood flow, resulting in an improved oxygen supply. Current guidelines of the American College of Cardiology–American Heart Association for the treatment of patients with acute myocardial infarction recommend immediate operative intervention in patients with septal rupture, regardless of their clinical status. In the STSA-CSD study, early repair occurring less than 7 days post-MI had much greater mortality than delayed repair occurring more than 7 days post-MI. The overall operative mortality from other study was 60% which is much greater than the STS-ACSD study which was 42.9% and had the greatest mortality in patients who underwent emergent surgical repair after VSR (less than 24 hours). A waiting period before surgery allows infarcted muscle to develop a firm scar to facilitate the surgical repair, however many patients died while awaiting surgery or underwent emergency surgery after sudden decompensation. According to our case, surgical intervention was delayed and despite adequate treatment and intra-aortic balloon counterpulsation (Use of circulatory support devices such as IABP may provide a survival benefit and stabilizes patients until surgery can be performed), after 3 days from revascularization patient was died.

## CONCLUSION

Ventricular septal rupture (VSR) is a rare but lethal complication of acute myocardial infarction (AMI). Mortality of patients is significantly depending on timing of surgery. Operative management of patients can be complex, and having a systematic approach is helpful. The cornerstone of medical management of VSR is afterload reduction, and may be considered routine care. According to our case, surgical intervention was delayed and despite adequate treatment patient was died. There is no clear evidence to guide the surgical management of patients who are in shock, as all approaches have shown extremely high mortality. Possible strategies include emergent surgery on individuals with marked

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haemodynamic instability and circulatory compromise.

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## HIGH-VOLTAGE SPARK TESTING OF INNER SURFACE OF SILICATE COATING COVERS OF PIPE

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### ABSTRACT

The results of researchers have done on study of the geometric shapes and sizes of macro and micro cracks on the inner surface of silicate-enamel coatings of pipes are presented in the current paper. The article gives detailed analyses of technological and operational caused defects in protective silicate coatings.

A scheme of experimental unit has been developed for a software-controlled installation for measuring of leakage current through macro and micro cracks in silicate-enamel pipe coatings.

The distribution of the density of defects along the silicate-enamel coating of pipes was measured by the detection of leakage current. By means of created flaw detector, it is possible to define the allocation of micro-cracks through the silicate-enamel coatings, and depict the graphic of dependence of these defects of their localization coordinates. The geometrical parameters of defined cracks have been figure out. In theoretical part the formula was developed that indicated dependence of leakage current from depth and length of micro-cracks.

**Keywords:** Flaw detector installation, control circuit, leakage current, geometrical dimensions of cracks, length of cracks, coating thickness, electrical resistance of cracks.

### INTRODUCTION

Under the influence of aggressive substances, including the atmosphere and temperature, metal pipe over time can lead to their failure. There are different methods to protect the metal surface. One of them is the application of silicate enamel coatings.

Silicate coating on industrial steel pipe is becoming more and more useful. This explains the cost-effectiveness and efficiency of this method of protection pipe from corrosion and solid deposits. Research show that silicate coating used successfully at high temperature and pressures as well as in highly mineralized

During operation, the coating is subjected to mechanical impacts, as a result on the inner surface of silicate covering of industrial pipe can occur micro-macro cracks. The main sources of defects are poorly prepared surface, violations of the technology of application and the lack of a general production coating covering. The disruption of continuity in at least one site causes the entire system to go out service. A more difficult problem of practical importance is to determine the birth appears moment of cracks in a silicate coating on pipes. For identifying cracks and testing of protective silicate coating continuity high-voltage spark testing method is recommended by foreign and Russian researches [1,2].

The review showed that modern silicate coatings from leading manufacturers (Table 1) have electrical strength E. The table content depicts that for the silicate coatings, there is a range of control voltages which is possible to carry out electrical spark monitoring without disturbing the protective properties of the coating [2,6].

Table1. Electric strength for various types of silicate coating

Type of coating	Cover features		
	Dielectric conductivity, E, KV/mm	Special resistance $\rho$ , Om mm	Control voltage U, KV/mm
Borosilicate coatings	5-7	$10^3$ - $10^4$	10-20
Alkaline coatings	4-6	$10^2$ - $10^3$	10-15
Ground coverings	8-10	$10^8$ - $10^{10}$	15-20
Special covers	10-12	$10^8$ - $10^{10}$	50-60

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Experimental research has shown that in silicate enamel coating the  $E$  is changed in range of  $5 \div 40 \text{ kV/mm}$ . Controlling voltage for electro-sharp method is chosen in diapason  $U_{min} < U < U_{br}$ , where  $U_{min}$  – minimal control voltage,  $U_{br}$  – breakdown voltage of protective coating. Breakdown voltage silicat-enameling coating  $U_{br}$  determined by electrical strength the material of the coating and its thickness  $U_{br} = E \cdot h$ .

All this confirms the possibility and optimality of using the electric spark on non-destructive testing method for monitoring of silicate coating, especially for products with a large area or for long objects.

Determining of the coordinates and geometrical dimensions of cracks in silicate-enamel coatings of pipes is more difficult in practice. Therefore, the idea is based on measuring the parameters of a corona electric discharge throw the inner surface of a pipe, which covered with a silicate-enamel protective layer. Periodic high-voltage pulses approximately 40 kV are applied to a mesh electrode on the interior surface of the silicate layer of a steel pipe and stimulated leakage current are recorded when micro cracks take place [3,4,6].

Technological scheme of the experimental measurement is shown in Figure 1.

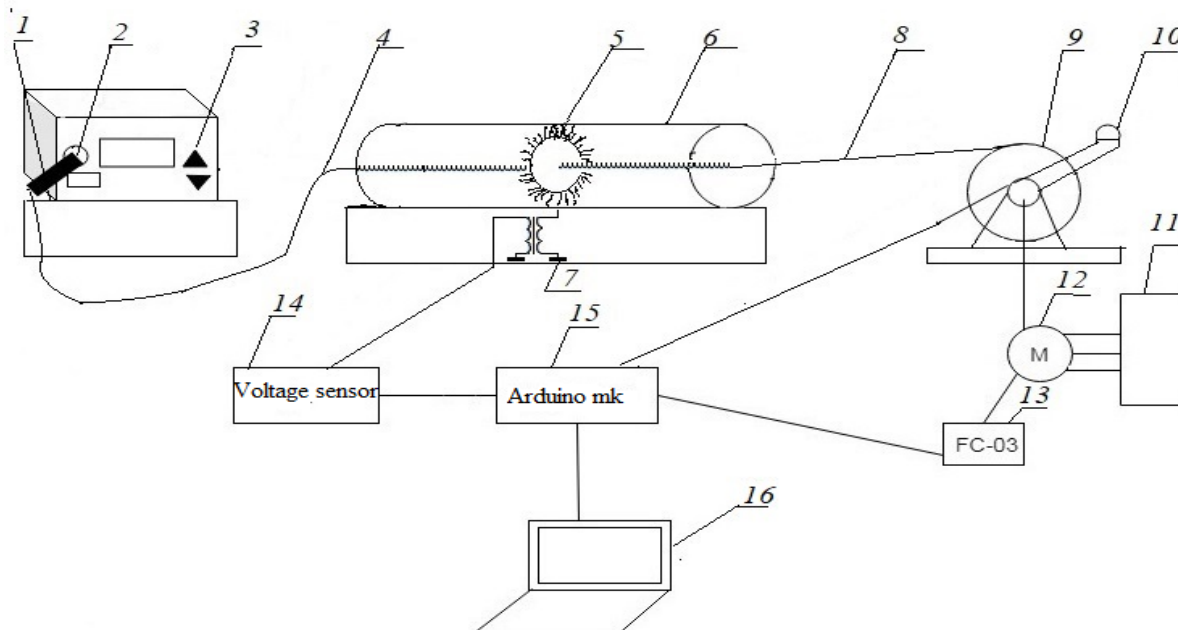


Figure 1. Schematic diagram of control and measurement on a flaw detection unit based on an 'Arduino' microcontroller  
 1 -VT-1 transformer; 2-connector of the transformer; 3- electric-spark flow detector ;4- connecting wire; 5-electrode; 6- silicate coated pipe; 7-TU3B series transformer;8- cylinder isolated cord; 9-rotating drum; 10-potensiometr;11-Inverter that regulates the speed of the engine; 12- engine; 13-FC03 sensor; 14- voltage sensor; 15-Arduino microcontroller; 16- personal computer

As usually, some of electro-spark flow detector consist of control high-voltage block, which connected with metal brush electrode. Operator can install suitable voltage for different brand of silicate coating according the table below. We have developed more effective and reliable apparatus, as adding sensors an microcontroller for identified micro cracks in size 1.5-3 mm. As illustrated in experimental scheme, the second end of the cord is wound on the drum (9). Mesh electrode move inside the testing pipe by the rotating drum with the aid of an electrical motor (12). The function of inverter to regulate the rate of displacement of the metal brush. Couplers connect with the drum shaft with the motor and motor shaft whit the inverter [3,5,6].

As it can be seen from the figure. The control and measurement scheme of a flaw detection system functionally consists of four parts:

a. Measurement of leakage currents from the mesh electrode (6) through cracks in the silicate-enamel coating, that run through the measuring transformer (1) and voltage sensor (14);

- b. Measurement of the length of the cord with an electrode (8), which is located inside the tested industrial pipe to determine the coordinates of the micro cracks position in the tube;
- c. Measurement of the speed of rotation of the induction motor (12) and comparing it with a given value;
- d. Control the speed of movement of the mesh metal electrode by slowing down or accelerating the speed of rotation of an induction motor pulling the cord attached to the electrode through the drum (9).

Measuring control functions at the flaw detector installation are implemented based on an Arduino microcontroller (15) with a special software developed for the above specific measurements and control functions. The result of diagnostic process operator can follow from the monitor of personal computer. Arduino microcontroller is send data as measuring leakage and position of electrode and then it is described graphically dependence. Calculating length and deep micro cracks inside of the silicate coat suppose theoretical expression, which applied in the practice. Analyzing determining geometrical parameters of cracks

The electric-spark flaw detector installation makes possible to measure the electrical resistance of the cracks of the coating. Micro cracks is defined when the induced current leakage will run throw the inner layer of silicate covering. These measurements determine the geometrical dimensions of all cracks according to the known formula in the following sequence. Knowing the value of the electrical resistance of cracks it is possible to calculated length of crack through the following formula [1,2].

$$r = \rho \frac{l}{s} \quad (1)$$

Where: r -is the electrical resistance of cracks to be measured;

$\rho$ - specific resistance of cracks in the pipe coating, taken as the maximum value  $\rho = 10 \text{ Om mm}$ ;

$l$ - length of cracks;

$s$ - cross-sectional area of cracks, which is calculated as follows:

$$s = b \delta \quad (2)$$

where: b-width of cracks, which maximum value is  $b = 1.0 \text{ mm}$ ;

$\delta$ - pipe coating thickness.

According to the famous Ohm's law, taking into account the thickness of the coating. We can calculate

$$I = \frac{U \delta}{r} \quad (3)$$

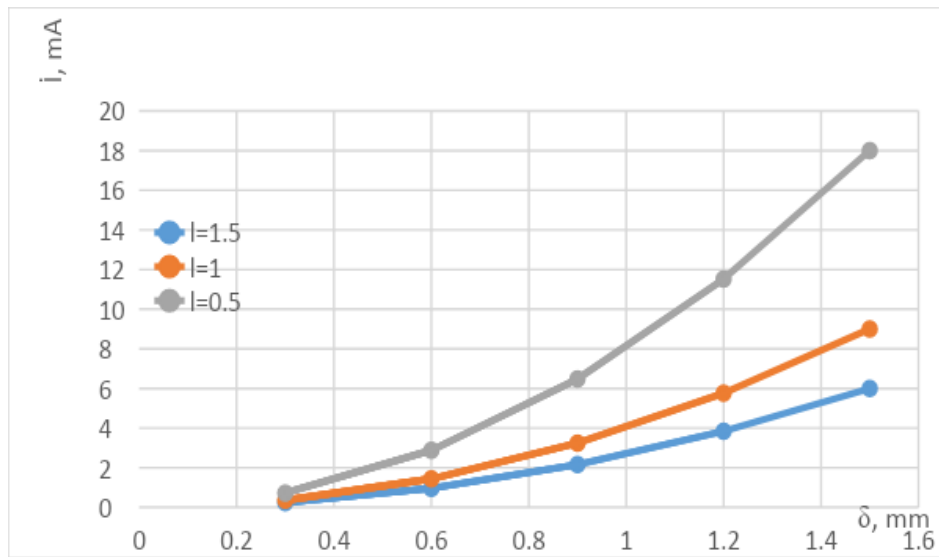
In our case, this U takes the value  $U = 40 \text{ KB}$ . Substituting the expression r from formula (1), inserted into formula (3), we finally determine leakage current as follow:

$$I = 40 \frac{\delta^2}{\rho l} \quad (4)$$

Thus, formula (4) makes it possible to determine the strength of the current (I) from the thickness of the coating ( $\delta$ ) and the length (l) of cracks in the pipe coating. In fig. 2a shows the results of experimental research of the dependence of the leakage current strength (I) through a crack on the values of the coating thickness ( $\delta$ ) and the length (l) of cracks. Experimental studies show that values of the coating thickness  $1=0,3 \text{ mm}$ ,  $2=0,6 \text{ mm}$ ,  $3=1,2 \text{ mm}$  gradually decrease dependence of the current strength on the crack length (l). Graphic illustrated sharp decrease in  $1=1,2$  points and increase in the length of cracks (l) to the maximum value  $l = 1.5 \text{ mm}$ . Current strength slightly reduce in  $2=0,3 \text{ mm}$ ,  $3=0,6 \text{ mm}$  values of coating thickness according to the indications of the flaw detector device.

In fig. 2b with values of crack lengths  $l_1=0,5 \text{ mm}$ ,  $l_2=1,0 \text{ mm}$ ,  $l_3=1,5 \text{ mm}$  the leakage current values change dramatically by the expanding the thickness of the pipe coating. This change is associated with increased adhesion between the inner surfaces of the metal and silicate - coating of steel pipe [2,3]. The basic parameters of the cracks in the pipe coating according to all indicates and calculations are presented in graphics.

a)



b)

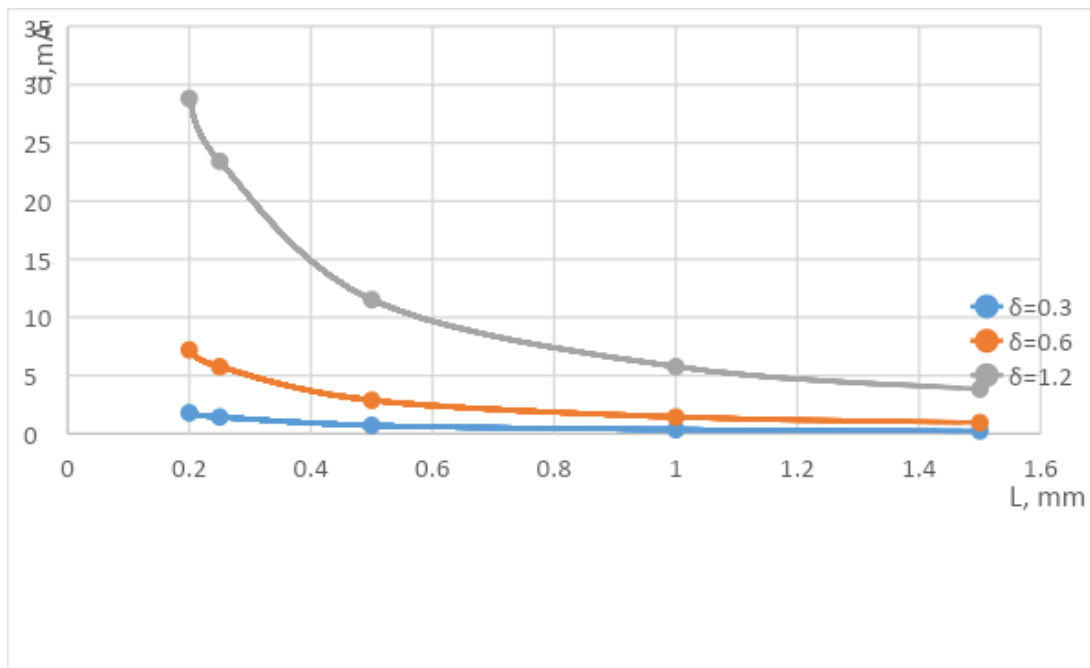


Figure 2. Graph of experimental dependence of the parameters of cracks  
a) graph of experimental dependencies of leakage currents on coating thickness  
b) graph of experimental dependencies of leakage currents on the length of cracks

As it follows from above consideration, in order to do quite complicated measurement of the geometrical sizes of cracks and their allocation along inner coating, it is necessary to arrange aggregation of higher voltage technique with scanning mechanisms of probing and smart measurement of small leakage currents. Only smart integration of the results of these

three procedures can give us opportunities to build full pictures on crack density distribution and their particular geometrical sizes.

Experimental equipment being aggregated from different units are managed and regulated by one microcontroller Arduino. This approach allows us to smoothly operates with mechanical parts of equipment such as pipe positioning, displacement of metal mesh electrode along inner surface of pipe, regulation of motor rotation and its direction.

Besides that the electronical parts of equipment allows operator to fully control all diagnostic system remotely.

This way the created equipment enable us to register, to keep and to store of all experimental results in PC and any external memory units. Result on distribution of cracks and their geometrical parameters to be handled statistically to derive the physical and technological related information to be able to improve and correct the technological procedure for recovering damaged places in silicate covering of inner surfaces of industrial pipe.

## CONCLUSION

At the same time, the developed flaw detection installation allows determining the coordinates of defined various cracks in the pipe coating. Research of the distribution of micro cracks on the inner surface of silicate-enamel coating for industrial sizes of standard pipes has been done.

Illustrated scheme of flaw detection control is presented for measuring the strength of leakage currents through cracks in a silicate-enamel coating of pipes. Given results of experimental studies of the graphical dependence of the strength of leakage currents through cracks for different coating thicknesses and cracks formed.

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## STABILITY OF A SMART WALKER IN FALL RELATED EVENTS

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### ABSTRACT

The development of a gait disorder leads to the loss of the ability to walk and increases the frequency of fall events. To help improve the lives of people affected by reduced mobility and return the patient's own dependency and confidence, smart walkers (SW) are used to empower the user's residual capacities and promote functional recovery. An example presented in this paper is the ASBGo Smart Walker, a customized motorized rehabilitation tool that provides an innovative combination of real-time multimodal sensory information. The design of this augmentative device is centered on safety and stability, both fundamental to provide rehabilitation to the affected individuals. In this paper, it is presented an assessment of the ASBGo Smart Walker's stability during forward and lateral falls. To evaluate if the SW has the ability to support the patient during a fall and not overturn, leading to fatal falls, theoretical stability tests were performed. These tests proved and verified the safety of the ASBGo SW, in most of the conditions and situations when the device is handled. Nonetheless, in order to minimize fall-related impact it is proposed in future work the implementation of prevention methods and strategies.

**Keywords:** Smart Walkers, stability, rehabilitation, falls, equilibrium

### INTRODUCTION

Locomotion is an important human faculty that can be affected by different types of pathologies leading to gait disorders, namely ataxia, that greatly impair human mobility at different levels [1], [2]. The lack of mobility in an individual's life can bring not only physical and psychosocial implications but also heavy social-economic consequences.

The number of people with reduced mobility capacities increases every year, and besides the elderly population, any person with neurologic dysfunctions and diseases such as poliomyelitis, spinal cord injuries, stroke, Parkinson, cerebral palsy and multiple sclerosis could also be affected [3], [4].

According to the World Health Organization (WHO), "Falls are the second leading cause of accidental or unintentional injury deaths worldwide"[5]. Some falls result in injuries (e.g., joint dislocations, fractures and/or hematomas) and may also result in a post-fall syndrome that includes early retirement, increasingly third-party and informal caregiver's dependence, loss of autonomy which will lead to a further restriction in daily activities [6–8]. Thus, falls and consequent injuries are major public health problems that often require medical attention with high cost treatments. Indeed, in 2015, the costs associated with fatal and non-fatal falls reached about \$637.2 million and \$31.3 billion in United States of America (USA), respectively [9].

Rehabilitation and daily exercise aim at restoring the disturbed locomotive function, resulting in fall prevention and postural stability improvement. In this way, the demand for walking aid devices such as conventional walkers, crutches or orthoses, has increased. These assistive devices help to stable the gait, support the body weight, prevent fatal and non-fatal falling accidents and secondary injuries enabling at the same time an adequate progress in the rehabilitation [10]. Nevertheless, the prescription of an assistive device should be done very carefully, which implies taking into account not only the patient's locomotion deficits, but also cognitive or sensory impairments [11]. To solve this paradigm, incorporation of robotic technologies has started to emerge as new category of walkers, integrating the mechanical structure to support the user, electronics, control systems and sensors. Such devices are known as smart walkers and present a similar mechanical structure to the four-wheeled walker [12].

In this work, related with ASBGo Smart Walker (Smart Walker for Mobility Assistance and monitoring System Aid), the device includes functionalities like physical support, cognitive and sensorial assistance, and integrates an interface able to read and interpret the user's command intentions to drive the device accordingly. Recent studies and improvements of the project are described in our previous works [13-14].



As verified, to provide safe and high quality care for people with gait disabilities, the healthcare industry requires clinically effective and well-designed medical devices that do not compromise the efficiency of the rehabilitation training and the patient's clinical condition. Hence, the main aim while developing a medical device is to guarantee the safety, ergonomic considerations and the simple and low-cognitive demands in handling the device.

Considering this premise, this paper will address safety of the ASBGo Smart Walker as an augmentative tool for the rehabilitation of gait related dysfunctions and pathologies. In this study, it will be considered the most common type of falls that can occur while using the device and evaluate its stability when submitted to the forces exerted by patients suffering from the latter pathologies. Thus, the paper also presents the main mechanical tests for the validation of the model. Furthermore, it is also presented a brief description of its features and rehabilitation programs.

This paper is organized as follows. In section II it is presented a brief system overview of the ASBGo SW and its main features and functionalities. Sections III and IV, respectively, presents the mechanical equilibrium tests' methodologies and the results in order to verify the conformity of the device to the safety principles. Section V contains the main conclusions and future work.

#### System overview

A Smart Walker is intended to be a device that can act as a versatile rehabilitation and functional compensation tool. It should be adaptive considering the necessities of its user and its handling should be safe. For the creation and development of a medical device, it should be taken into account for whom it is intended (end-user). This brings crucial characteristics and limitations to the development of the final prototype. The first goal is to guarantee the safety of the device to its user. Second goal is the attractiveness of the device, which means that it has to be ergonomic and comfortable. Other goal is to provide multifunctionality to the walker, being adjustable to the user and able to incorporate and solve various problems such as being motorized and help its user in various tasks (e.g. sit and stand from a chair).

The development of the ASGo Smart Walker aimed to achieve those goals considered in its basis a 4-wheeled motorized walker equipped with multiple sensors and electronic components that provide different functionalities and characteristics. The physical structure of the smart walker is made of aluminum alloy, has two front caster wheels, and two rear wheels coupled to the motors (direct connection). The forearm supports are placed on an abdominal surface area, made of wood, with a curvature in the contact area with the user. This surface is used to center and correct the user's posture, independently of his/her anatomy also it leads to a posture with normal flexion of the back while walking. Detailed considerations, modifications and the implementation's process of the mechanical design can be consulted in previous work [13] and the resulting prototype subsystems is shown in

Figure 1 **Error! Reference source not found..** It should be noticed that most of the SW weight (electronics and heavy components) was placed in the lower part to reduce the risk of instability and provide a better general equilibrium.

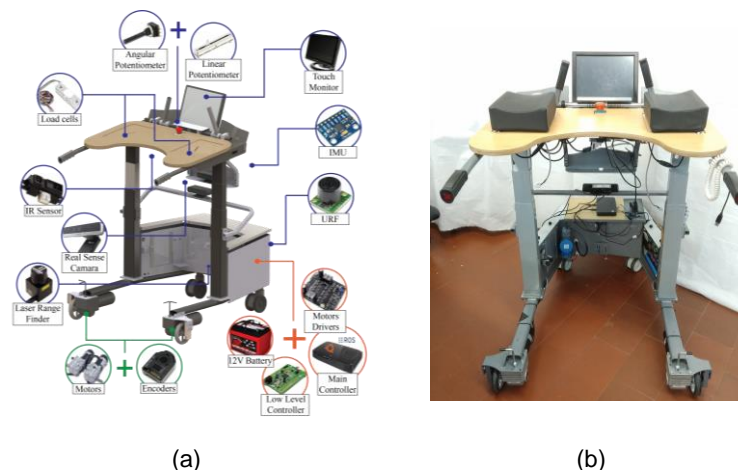


Figure 1 - ASBGo system overview: (a) mechanical frame and its subsystems and (b) prototype.

Besides acting as a gait assessment tool, ASBGo Smart Walker's subsystems, mainly its sensors, allow the walker to provide information about the user gait pattern, identify the movement intentions by evaluating the direction and speed, and ensure security conditions by detecting possible falls. Thus, the device includes functionalities like physical support, manual, autonomous and shared-control guidance, user's state monitoring security and integrates an interface able to read and interpret the user's command intentions to drive the device accordingly [15].

The ASBGo Smart Walker is well characterized by its maneuverability based on user's physical manipulation through a handlebar: start to walk, walk in front, slow down and turn left or right. This mode enhances visual and cognitive capabilities, as well as motor coordination. During its handling the user is always supported by his/her forearms on the wood table. This position and posture adopted by the user will be the one considered for stability assessment tests, as we will see in the next section.

### Methodologies

As was verified in Section I, a fall affects the self of confidence of an individual, his/her dependency and daily life activities, mainly the elderly and the population affected by gait pathologies. Therefore, it is important to understand and study the nature and extent of stability of the assistive device in terms of forces applied on it. Also, it is necessary to validate the device accordingly to its equilibrium in the presence of a fall, hence assess the possibility of existing risks.

Regarding the human anatomy, falls do not always happen in the same way and in the same direction. The anatomical planes which a fall occur are the sagittal and coronal planes, where four different types of falls exist: forward, sideward (left and right) and backward [16].

In the current study, the stability of the ASBGo SW, in the presence of falls, was theoretically evaluated considering a three-dimensional mechanical model of the SW's prototype in sagittal, frontal and top plane. Many calculations in mechanics are greatly simplified by making use of a system's center of mass. Thus, this parameter was determined using a CAD Software, along with all the dimensions necessary for the study. The goal is to evaluate the ground reaction force applied on the front-wheels and rear-wheels. If both forces are positive the wheels will be lifted, hence the walker is not stable as a gait assistance device. For that, we defined the net external torques as zero for a rotational equilibrium. Figure 2 illustrates the axis where the forces were evaluated.

In this paper, it was considered only one condition when the patient uses the walker in manual guidance - the user does not apply any kind of push or pulling force, thus only applying his/her weight on the device. Moreover, it was considered forward and lateral falls since these types are the ones most relevant to the study when handling smart walkers.

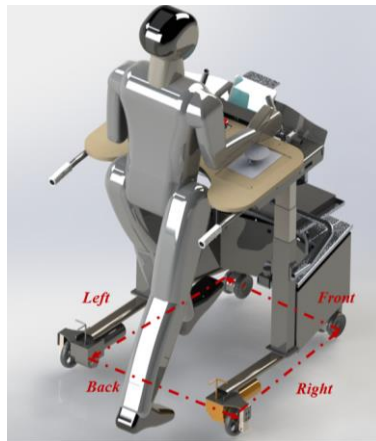


Figure 2 – Representation of the SW and the user and the four axes by which a fall would occur, and by which the device will rotate over.

Following the works [17-18], and considering the provided support of the abdominal surface area of the ASBGo walker, it will be studied a force range of 0.5 kN to 1.5 kN for forward falls with an angle of application of  $60^\circ$  on the walker. For lateral falls, it will be taken into account the total body weight of the patient supported by the walker in only one side (right

or left). The equations were divided accordingly to the walking aid frame base (see Figure 2) and to the plane where the torques ( $M_0$ ) take action (equilibrium of the moment around  $x$ ,  $y$  and  $z$  axis) accordingly to equation for a moment of a force  $F$  about a point  $O$  (Eq. 1). In the case of this work,  $O$  is considered as the points of contact of the wheels to the ground.

$$M_O = r \times F = \begin{vmatrix} i & j & k \\ r_x & r_y & r_z \\ F_x & F_y & F_z \end{vmatrix} \quad (1)$$

Friction forces were considered sufficient for counteract the locking force of the wheels, thus it was not included in calculations. The main findings of this study are presented and discussed in section IV.

### Discussion

The moment about an axis was measured for four axes (left, back, right and front) as stated in section III, according to forces ranging from 0.5 kN to 1.5 kN for forward falls. In the case of lateral falls, it was only considered the total body mass weight supported, by the walker's structure, on either side individually (right or left), for individuals weighting from 50 to 150 kg. Thus, the results (Figure 3) describe the moment about an axis [Nm] as function of Weight [kg]/Force [kN], for forearm support.

To verify the equilibrium and stability of the walker, the lines which represent the values for the four axes, must be below the 0 Nm moment value (represented by the red straight line). Above 0 Nm it suggests that the device presents some instability regarding the respective axis, and therefore it will rotate around it.

It must be noted that the walker is considered symmetrical along the sagittal plane, thus the moment exerted on left and right axis must coincide in all events, except the ones for lateral falls.

Considering the manipulation of the walker, with the increasing of the force applied on the walker structure, the rotation (moment) exerted around the front axis (line of the front wheels) also increases (Figure 3 (a)), surpassing the red line (zero value). As discussed in Section III, the force applied on a forward fall was considered with an angle of application of  $60^\circ$ , which means that exists a  $x$  component value in forward direction that enhances the possibility of rotation of the walker around the front axis.

It can be noted that, as seen by the figures, the graphic profiles are very similar between each other that corresponds to the same situation, only differing the axis in which the fall occur. If the fall occurs on the right side, then the most affected axis (more positive one) is the right one (Figure 3 (b)). The same happens for the left side (Figure 3 (c)).

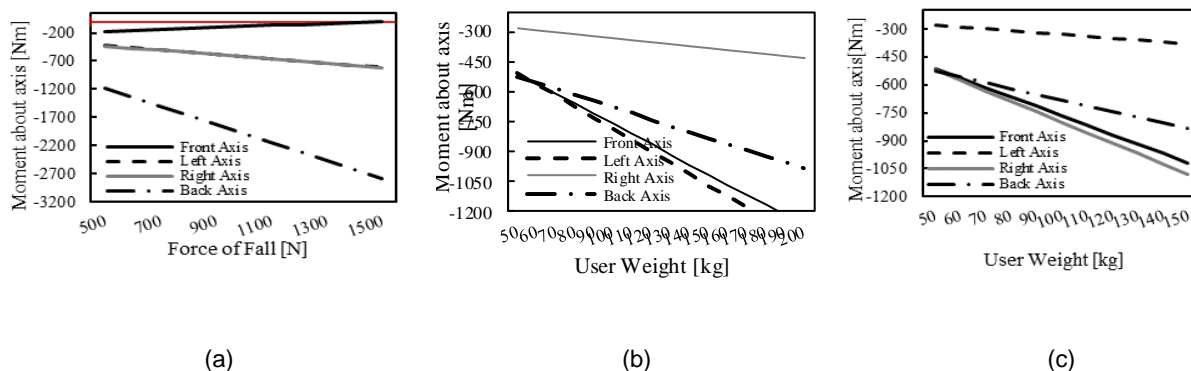


Figure 3 - Results of the moment about the four axis for forward falls (a) and lateral falls on the right (b) and left sides (c).

In overall, the results proved and verified the safety of our ASBGo smart walker, in most of the conditions and situations

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that the device is used. The wood table with forearm support is the one most used **during rehabilitation, and this study showed that the smart walker is prepared to withstand the user even** during the presence of falls, forward and even lateral.

### Conclusion and Future Work

Some falls, fatal and non-fatal, result in several injuries and the cost associated with medical treatment is high. This is a complex problem that requires several steps in order to be tackled. Firstly, it is crucial to prescribe the correct augmentative walking aid device, accordingly to the user needs. That device should be prepared to support the patient during a fall event, i.e., to be stable and avoid overturning or make uncontrolled movements during its handling. In this way, it will guarantee the balance, equilibrium and most important safety of the user, and thus improving his/her confidence during rehabilitation.

In practice, safety can only be considered in relative terms. All devices carry a certain degree of risk and could cause problems in specific circumstances. Medical devices should be designed and manufactured in such a way that when used under conditions and purposes intended they will not compromise the clinical condition or the safety of the user.

Based on this assumption, this article presented theoretical stability tests performed on a smart walker during fall events to estimate the safety, or the eventual potential risk of hazard that could result in problems. Overall, forward falls are the most critical situation verified, during the use of the forearm support. Nonetheless, the results were positive to the extent that the ASBGo Smart Walker is prepared to withstand and support the user on fall related events in most of conditions and situations that the device is used.

Nonetheless, in order to minimize fall-related impact a few prevention methods and strategies must be developed based on non-wearable and wearable sensors. Most of these sensors include depth cameras, thermal sensors, ultrasonic array, force sensing resistors (FSR) or even inertial measurements units (IMU's).

The research team hopes to introduce the device in the market in the upcoming years. Aiming to that goal it is important to also study the stability of the SW in sloping surfaces or in other device's handling modes. Clinical trials are also being conducted in hospital environment with ataxic patients in order to provide the necessary experience with the ASBGo smart walker and understand its associated risks and safety for rehabilitation purposes. Moreover, the group is working on systems to detect and prevent falls in order to improve the user's stability and balance.

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## SYNTHESIS AND BIOLOGICAL ACTIVITY OF 2,3,4,6-TETRA-O-ACETYL-1-O-(2-CHLORO-3-PHENYL THIO PROPYL)- $\beta$ -D-GALACTOPYRANOSE

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### ABSTRACT

We studied the reactions of acetylaryl glycosides with phenylsulfonyl chloride in the presence of a benzoyl peroxide catalyst. A new sulfur-containing glucoside was synthesized: 2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-Galactopyranose (3).

The bactericidal properties of  $\beta$ -O-(2-chloro-3-phenyl thio propyl)-D-Galactopyranose (4) of the obtained product after deacetylation were studied. With the help of the computer program PASS (Prediction of Activity Spectra for Substance) onlines were able to predict the range of activity of substances. The obtained result established correlations on bactericidal properties between biological activity and the intended biological activity. The structure of the synthesized compounds was determined by physico-chemical research methods.

**Keywords:** Alliglycosides, acetylation, benzoyl peroxide, phenylsulfonyl chloride, biological activity.

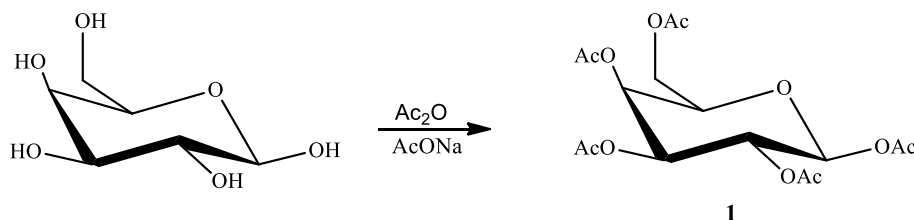
**Introduction:** Important compounds of carbohydrate origin are thioglycosides. Recent studies have shown that these compounds are characterized by very significant biological activity and are included in the composition of vitamins, enzymes and coenzymes. All organisms need sulfur [1-3], which it absorbs, in the form of any need. Sulfur-containing compounds are used as an antispasmodic effect, as well as an extension of the capillaries.

For the synthesis of sulfur-containing galactose, the reaction of the addition of monosaccharides (galactose) with phenylsulfonyl chloride was first studied. The starting compounds are synthesized by known methods. [4-6].

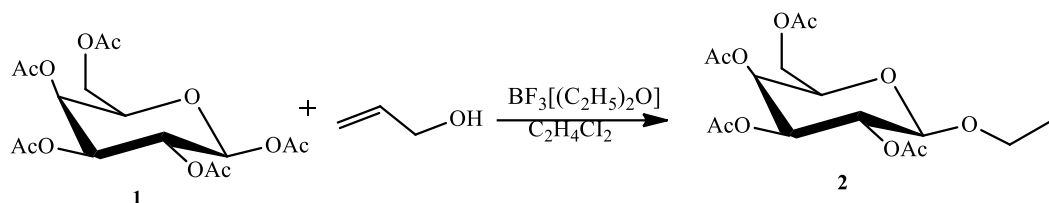
**Experimental part.** With acetylation of galactose with acetic anhydride in the presence of sodium acetate on the obtained  $\beta$ -acetylated product (1) by the action of allyl alcohol and  $\text{BF}_3[\text{O}(\text{C}_2\text{H}_5)_2]$  was synthesized 1-O-allyl-2,3,4,6-tetra-o-acetyl- $\beta$ -D-galactopyranose (2). A new compound 2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (3) was synthesized at room temperature in chloroform, in the nitrogen region, with mixing and adding phenylsulfonyl chloride solution (in  $\text{CCl}_4$ ).

The synthesized compounds are white colored crystals, very soluble in chloroform. The composition of the derivative was determined by physico-chemical research methods.

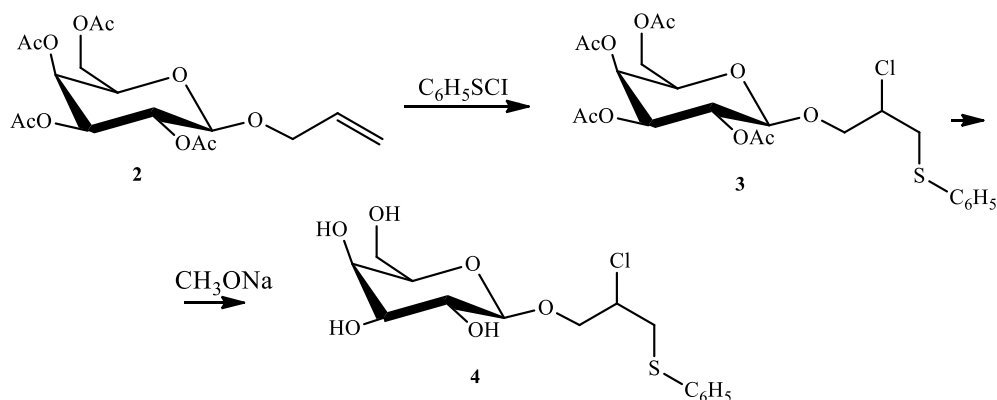
In particular, the definition of optical rotation, using elemental analysis, IR and  $^{13}\text{C}$  Spectroscopy. The purity of the substance was checked using thin-layer chromatography using "Silufol" plate in the following solvent system by volume: chloroform-ethanol 2:1. Optical rotation was measured on a SU-3 universal saccharimeter at  $20^\circ\text{C}$ . IR spectra of the samples were taken on a UR-20 spectrometer in KBr tablets.  $^{13}\text{C}$  NMR was recorded on a Bruker AM-300, 75.5 MHz spectrometer in deuterochloroform:



Allyl-2,3,4,6-tetra-O-acetyl- $\beta$ -D-galactopyranose (2) was obtained in the interaction of penta-O-acetyl- $\beta$ -D-galactose (1) with dichloroethane and with allylic alcohol with catalyst  $\text{BF}_3[(\text{C}_2\text{H}_5)_2\text{O}]$ :



By dissolving Allylated monosaccharides at room temperature in chloroform in the nitrogen region, in constant movements with the addition of a solution of phenylsulfonyl chloride ( $\text{C}_6\text{H}_5\text{SOCl}_2$ ), a new compound was synthesized - 2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (3) 51.8% with output, from which de-acetylation were obtained 1-O-(2-chloro-3-phenylethiopropyle)- $\beta$ -D-galactopyranose (4).



With the help of computer program PASS Online [7-8-9]. PASS (Prediction of Activity Spectra for Substances) Online predicts over 4000 kinds of biological activity, including pharmacological effects, mechanisms of action, toxic and adverse effects, interaction with metabolic enzymes and transporters, influence on gene expression, etc.

Computer program Evaluated Estimated Biological Activity 2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (3) (Table 1.) and his deacetylated product-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (4) (table 2).

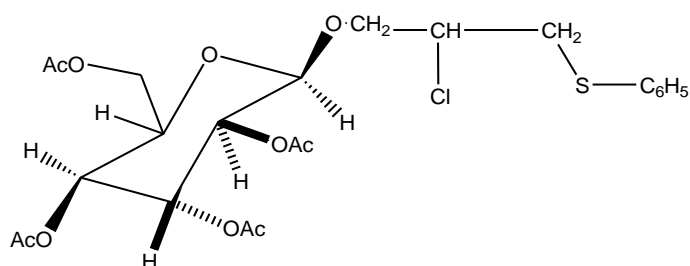


Table 1.

**2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)-β-D-Galactopyranose (3)**

(Pa&gt;Pi ; Pa&gt;0,5)

Activity	Pa*	Pi**
Benzoate-CoA ligase inhibitor	0,901	0,005
Cholesterol antagonist	0,851	0,004
Antineoplastic	0,847	0,007
Antileukemic	0,796	0,004
CDP-glycerol glycerophosphotransferase inhibitor	0,812	0,027
Membrane permeability inhibitor	0,753	0,020
Antineoplastic (breast cancer)	0,731	0,005
Antineoplastic (cervical cancer)	0,709	0,004
Mannotetraose 2-alpha-N acetylglucosaminyltransferase inhibitor	0,699	0,027
Immunosuppressant	0,679	0,019
Antifungal	0,639	0,014
Prostate cancer treatment	0,618	0,005
Alkenylglycerophosphocholine hydrolase inhibitor	0,632	0,041
Antibacterial	0,566	0,011
Mycothioli-S-conjugate amidase inhibitor	0,565	0,013
Beta glucuronidase inhibitor	0,571	0,020
Nicotinic alpha4beta4 receptor agonist	0,594	0,043
Angiogenesis stimulant	0,550	0,008
Hypolipemic	0,554	0,029
Anaphylatoxin receptor antagonist	0,557	0,049
CYP2H substrate	0,576	0,079
Sugar-phosphatase inhibitor	0,534	0,073

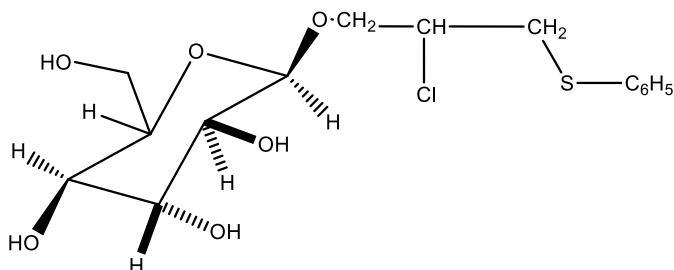


Table 2.

**1-O-(2-chloro-3-phenyl thio propyl)-β-D-galactopyranose (4) Predicted activity spectrum (Pa>Pi ; Pa>0,5)**

Activity	Pa	Pi
Benzoate-CoA ligase inhibitor	0,956	0,002
Alkenylglycerophosphocholine hydrolase inhibitor	0,956	0,002
Sugar-phosphatase inhibitor	0,927	0,003
Cholesterol antagonist	0,923	0,002
Anthranilate-CoA ligase inhibitor	0,914	0,002
CDP-glycerol glycerophosphotransferase inhibitor	0,909	0,008
Fucoesterol-epoxide lyase inhibitor	0,881	0,004
Licheninase inhibitor	0,877	0,001

Mycothiol-S-conjugate amidase inhibitor	0,834	0,002
Antileukemic	0,793	0,004
Antitoxic	0,770	0,004
Protein-tyrosine sulfotransferase inhibitor	0,766	0,003
Antineoplastic	0,771	0,015
Membrane permeability inhibitor	0,753	0,020
Vasoprotector	0,746	0,008
Angiogenesis stimulant	0,722	0,003
Sweetener	0,717	0,002
Cytostatic	0,714	0,009
Antineoplastic (cervical cancer)	0,708	0,004
Membrane permeability inhibitor	0,718	0,032
Antithrombotic	0,679	0,009
Lipotropic	0,659	0,005
Hepatoprotectant	0,641	0,010
Antineoplastic (breast cancer)	0,632	0,008
Beta glucuronidase inhibitor	0,612	0,012
Antifungal	0,602	0,018
Chitosanase inhibitor	0,591	0,007
Prostate cancer treatment	0,579	0,005
Antiinfective	0,574	0,015
Antibacterial	0,532	0,014
Antimetastatic	0,532	0,014
Immunostimulant	0,545	0,030
Antidiabetic	0,525	0,020
Hypolipemic	0,501	0,037

The estimation of pharmacological potential of compounds showed, that 1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (**4**) has a wider range of biological activity than 2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (**3**).

A comparison of the PASS predictions data showed, that similar biological activities: *Cholesterol antagonist*, *Sugar-phosphatase inhibitor*, *Mycothiol-S-conjugate amidase inhibitor*, *Beta glucuronidase inhibitor*, compound (**4**) has with higher Pa value than substance (**3**) and biological activity: *Antifungal*, *Prostate cancer treatment* is relatively low Pa.

Based on a generalization of a vast literary material, biologically active compounds are characterized by a certain specificity of composition and structure. Structural modification of compounds by introducing various molecules or atomic groups in a molecule can determine the effect of molecular separation of fragments on bioactivity.

In our case, the biological activity in compound **4** determines the acetylated groups, which may be the result of spatial exposure. Additional information about the biological spectrum will be further confirmed. Using the PASS Onlains computer program, the toxic effects of the synthesized substances were determined (3,4).

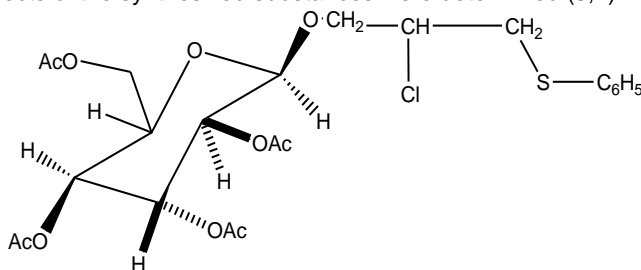


Table 3.

Possible adverse & toxic effects for compound 3 (prediction is based on clinical manifestations, which are sometimes observed in a few or even in a single patient)

$Pa > Pi$ ;  $Pa > 0,6$

Possible adverse & toxic effects	Pa	Pi
Weakness	0,892	0,008
Diarrhea	0,889	0,012
Muscle weakness	0,859	0,009
Neurotoxic	0,840	0,013
Toxic	0,837	0,021
Drowsiness	0,815	0,019
Sleep disturbance	0,747	0,032
Conjunctivitis	0,725	0,032
Hematotoxic	0,710	0,040
Toxic, gastrointestinal	0,703	0,044

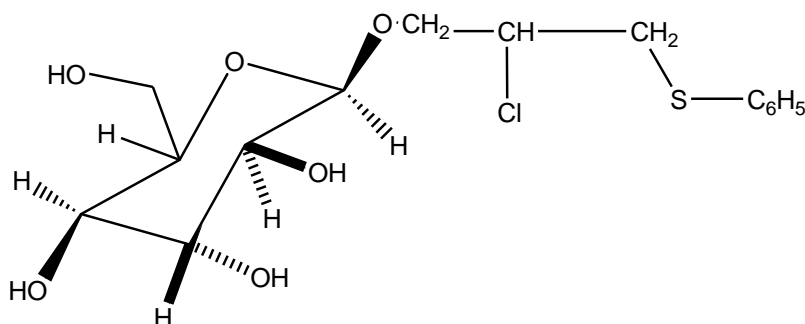


Table 4.

Possible adverse & toxic effects for compound 4 (prediction is based on clinical manifestations, which are sometimes observed in a few or even in a single patient)

$Pa > Pi$ ;  $Pa > 0,6$

Possible adverse & toxic effects	Pa	Pi
Diarrhea	0,907	0,010
Neurotoxic	0,885	0,007
Dyspnea	0,860	0,009
Toxic, gastrointestinal	0,817	0,023
Fatty liver	0,797	0,004
Drowsiness	0,809	0,020
Hematotoxic	0,803	0,026
Behavioral disturbance	0,791	0,025
Toxic	0,791	0,029
Weakness	0,782	0,021
Sleep disturbance	0,777	0,027
Hyperglycemic	0,743	0,019
Coma	0,733	0,016
Anemia	0,724	0,023
Nausea	0,731	0,035
Embryotoxic	0,708	0,021



The results show that 1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (**4**) has a wider range of Toxic effect then 2,3,4,6-tetra-o-acetyl-1-O-(2-chloro-3-phenyl thio propyl)- $\beta$ -D-galactopyranose (**3**). Comparison of obtained datasimilar Toxic effect of substance (**4**) and substance (**3**): Diarrhea, Neurotoxic, Toxic gastrointestinal, Drowsiness, Hematotoxic, Toxic, Weakness, Sleep disturbance. At the same time, substance **4** was diagnosed with Diarrhea, Neurotoxic, Toxic gastrointestinal, Hematotoxic, Toxic, Weakness, Sleep disturbance, the higher Pa values of toxic effects than substance **3**. While the toxic effect of drowsiness is relatively low Pa.

## CONCLUSION

From a theoretical and practical point of view, it is especially interesting to establish some correlation between structure and biological activity, which serves to search for the biological properties of new compounds with preliminary predictions. Identify the biologically active groups in the substance, determine which fragment is the biological activity of the compound. Our goal is to serve this goal.

By assessment of structure-activity relationships biological activity spectrum of synthesized glycosides have been revealed. The results of the study will enable us providing selection of the most prospective compounds from the set of synthesized samples.

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## ANALYSING EFFECTIVE TIERED OIL SPILL PREPAREDNESS AND RESPONSE MODEL FOR AZERBAIJAN AND USAGE AVAILABILITY OF REMOTE SENSING METHODS

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### ABSTRACT

Oil spill disasters are a very serious problem in the world. The accidents happened in the past showed us that many people can die, a lot of money can be spent, and the environment can be damaged seriously during the accidents. Therefore, the countries which have a relationship with oil and gas production and transportation should be prepared for any type of oil spill accidents with specialised responders, modern technologies and equipment and other additional supports. There a lot of factors which should be considered on oil spill preparedness and response model. In this article, using the case of Azercosmos surveillance, modelling and visualisation experience in Azerbaijan has been analysed and available technologies have been discussed and suggestions have been presented. The last accident in Gunashli oil field proved that the accidents are unavoidable. Therefore, we should be ready for Tier 1, 2 and 3 oil spill accident in order to protect human life, the environment and the reputation of the country.

**Keywords:** oil spill, remote sensing, oil spill response, Tier 1, 2, 3, modelling, dispersant

### INTRODUCTION

As shown in Figure 1, in history, a lot of oil spill accidents happened in different points of the world and unfortunately, they still continue in a small, medium or big scale every day. Of course, they had a very negative impact on the environment, human health, economy, etc. Therefore, all countries which do oil and gas activities have to be ready and prepared to minimize the impact of oil spill on the environment. Being ready and prepared means, not only preparing tactical and strategical plans for oil spill accidents but also preparing competent specialists, allocating for modern technologies such as skimmers, dispersants, remote sensing equipment, etc. Since Azerbaijan is an oil and gas producing country, we also have oil spill risk in offshore and onshore. Therefore, we have to be ready for any scale of oil spill in Azerbaijan. In this article which was inspired by the training course conducted by "Oil spill response" LTD UK in Azerbaijan on 24-26 May 2017, Azerbaijan's oil spill preparedness and response model was investigated and its experience has been assessed on the basis of the training course.

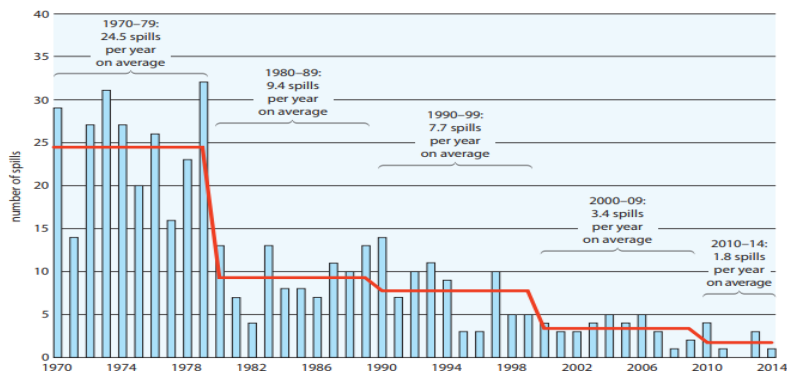


Figure 1. The number of large spills (> 700 tonnes) from oil tankers, 1970 to 2014

What is tiered preparedness and response?

Tiered Preparedness and Response is an effective planning approach for using below-mentioned purposes [1]:

- defining and structuring levels of oil spill response capabilities
- planning to send suitably and all needed resources to the location where the incident took place
- enabling response escalation for any scale of oil spill accident

Mainly three resources are used in the Tiered Preparedness and Response process:

- responders (a)
- equipment, and (b)
- additional support (c)

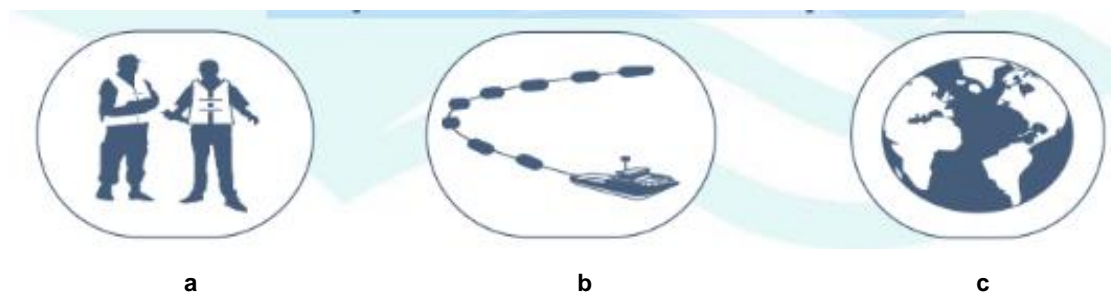


Figure 2. Resources needed for oil spill response operations

Why defining preparedness and response model is very important?

- protecting the environment and minimize the damage of the spill
- preventing any risk to health and safety of people
- preventing big amount of oil loss, consequently money loss (can be direct or indirect such as compensation to people, country, company, mobilisation of equipment, etc.)
- preventing the reputation of a country or company, etc.



Figure 3. Receptors which might be damaged by any possible oil spill  
Explanation of response tiers and examples for each of them [2]

### Tier 1: Spill in local scale

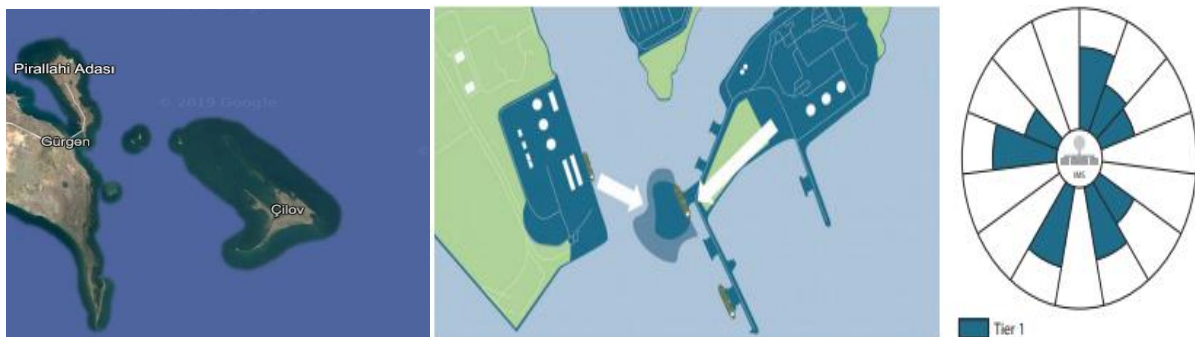


Figure 4. Illustration of a Tier 1 response

#### Responders

- trained response staff and ready for emergency situations
- local contractors specialised in oil spill response

#### Equipment

- on-site or locally available with arrangements for operative mobilization
- suitable for location factors in terms of geographical location, weather condition or logistics
- deployment times and methodologies are often predetermined
- provision of logistic support is in place

#### Additional support

- despite some facilities relating to Tier 1 capability is not kept permanently on-site, but are available when is need, for example: waste skips, storage trucks, personnel transport, etc.
- provision of supportive elements such as, additional security, accommodations, etc.
- other technical support and specialised resources

#### Example scenarios for explaining Tier 1 oil spill

The below-mentioned events require Tier 1 capabilities at a fixed location, such as:

- the overfilling of a tank
- a leaking valve
- break in a transfer hose or pipeline

### Tier 2: Spill in national or regional scale



Figure 5. Illustration of a Tier 2 response

#### Responders

- professional dedicated response staff and additional responders

- the locally sourced workforce may be supervised by the Tier 2 provider equipment

#### Equipment

Tier 1 resources used to mount an initial response, and the industry's response toolbox, including:

- dispersant capabilities
- at-sea containment and recovery equipment
- protection booms
- shoreline and inland clean-up equipment
- recovered oil storage capabilities

Amount and type appropriate for potential scenarios

#### Additional support

- designated oil spill response cooperatives
- specialized Tier 3 services
- cooperation at the local/regional government level
- a network of additional responders

#### Example scenarios

An oil spill which requires more specialised capabilities than Tier 1 requirement such as:

- a ruptured pipeline in difficult terrain
- a spill that crosses regional boundaries and requires the involvement of additional parties

Tier 3: Spill in global/international sphere



Figure 6. Illustration of a Tier 3 response

In these operations, local, regional and even national resources are involved in. Compared to the Tier 1 and 2, during Tier 3 events usually call for the mobilization of very substantial resources and operative movement across international borders and require very well managed response operation with the participation of specialised responders on the oil spill. There is also an International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC) which was adopted on 30 November 1990 and entered into force on 13 May 1995. According to these principles of the convention, industry and government have an internationally recognized framework for building preparedness and response capabilities to match the oil spill risks prevailing in any situation worldwide.

#### Responders

- specialised and competent staff
- Tier 3 responders integrate with local and Tier 2 responders at all levels

#### Equipment

Tier 1 and Tier 2 resources used to mount an initial response, and the industry's global response toolbox, including:

- high-volume aerial and subsea dispersant capabilities
- large-scale containment and recovery equipment
- protection booms
- in-situ burning capabilities
- specialized shoreline and inland clean-up equipment

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- oiled wildlife response capabilities
- logistics capabilities

#### Amount and type appropriate for potential scenarios

Additional support

- fully equipped Tier 3 response centres
- governmental or cooperative Tier 3 capabilities
- involving additional expert responders

#### Example scenarios

An oil spill that requires a wide range of available resources, such as:

- big amount of leakage from tanker crashes and large spread in the sea
- an accidental discharge of a relatively modest volume of oil in an ecologically sensitive location

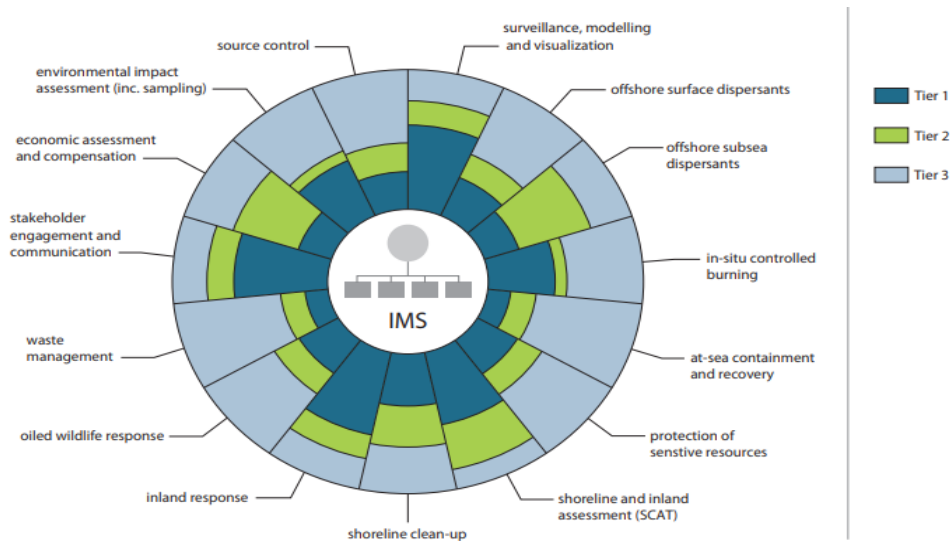


Figure 7. Example of the completed evolved tiered preparedness and response model

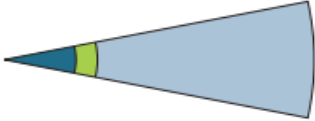

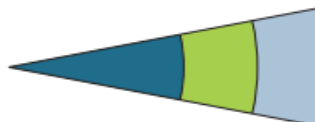
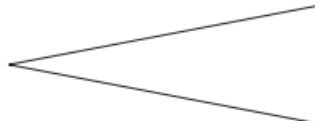
	Tier 1	Tier 2	Tier 3
<p><b>Example A:</b> This operation can be well served by Tier 3 due to strong logistical links, which have been tested and are robust enough to minimize the need for stronger local or regional capability.</p> 	Some locally available dispersant capability exists. In this case through vessel mounted spray systems.	Additional 10 m <sup>3</sup> of dispersant is provided through a mutual aid agreement.	The majority of surface dispersant capability is provided through Tier 3. In this case through wide area aerial capability and access to large dispersant stocks.
<p><b>Operation B:</b> This operation is very remote and the logistical framework is uncertain due to weather and political instability. Tier 3 support is available but local conditions have driven a need to build local Tier 1 capability to a level that can mitigate most of the risk.</p> 	Locally provided dispersant capability through a large pre-positioned stockpile, vessel and helicopter-mounted application systems.	An additional 10 m <sup>3</sup> of dispersant is provided through a mutual aid agreement.	Further stocks of dispersant are available from the Tier 3 provider, in addition to a larger aerial delivery system.
<p><b>Operation C:</b> This operation is well served by a Tier 2 organization that is close by; however, due to the risk of oiling of sensitive mangrove systems in the vicinity, the rapid first strike Tier1 capability is bolstered.</p> 	Robust locally provided dispersant capability through the pre-positioning of vessel mounted application systems in the field.	An additional 100 m <sup>3</sup> of dispersant and a small fixed wing aerial system is provided through a mutual aid agreement.	Further stocks of dispersant are available from the Tier 3 provider, in addition to a large aerial delivery system.
<p><b>Operation D:</b> This operation is terrestrial and so dispersants are not an appropriate response option.</p> 	n/a	n/a	n/a

Figure 8. Tiered capability of surface dispersant provision in four example response scenarios

There might a question be arisen that which Tier 3 centres exist in the world in case of any big oil spill

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accident? Globally there are very few non-profit international Tier 3 Response Centres. Their locations have been determined according to the occurrence of major oil spills from shipping and where the greatest risks exist. They are shown below:

Table 1. Tier 3 response centres in the world [2]

Name	Location	Area of operation
Australian Marine Oil Spill Centre (AMOSC)	Victoria, South East Australia	Territorial Australia and South West Pacific
Clean Caribbean and Americas (CCA)	Florida, United States	Caribbean and Latin America
Oil Spill Response and East Asia Response Limited (OSRL/EARL)	Southampton in the United Kingdom, Singapore and Bahrain	Worldwide

There are also different international oil spill response organisations such as the Marine Spill Response Corporation (MSRC), which has substantial resources distributed at strategic locations around the USA and Brazil — Environmental Defence Centres (CDA) — for national response and international support across South America, etc. In addition, commonly the following software such as GLOBAL Preparedness OSCAR-3D, EMEA / APAC Response OILMAP - 2D, ADIOS® (Automated Data Inquiry for Oil Spills and OSIS is used in oil spill modelling.

#### Availability of oil spill preparedness and response in Azerbaijan

As mentioned in Figure 7, fifteen areas of response capability are most commonly required during oil spill preparedness and response operations. Currently, two big international companies SOCAR and BP are operating in Azerbaijan and both of them have Oil Spill Response Plan. BP Azerbaijan has its own Tier 2 centre, while SOCAR is in the process of building its Tier 2 centre. Regular simulation training is conducted to train workers and analyse the current experience of the companies. Also, equipment is inspected, responders' knowledge is refreshed and the condition of additional support is analysed. Due to exceeding volume limit, only surveillance, modelling and visualisation opportunity in Azerbaijan will be analysed in this article. Remote sensing technologies are very useful in oil spill mapping, determination of oil quantity and type and controlling the direction of oil spills [3]. There are a lot of remote sensing methods to control oil spill such as vessels, satellite, drones / UAV's aircraft, helicopters, helium balloons, etc. and they have very big advantages on operative and effective oil spill detection and response operations [4].

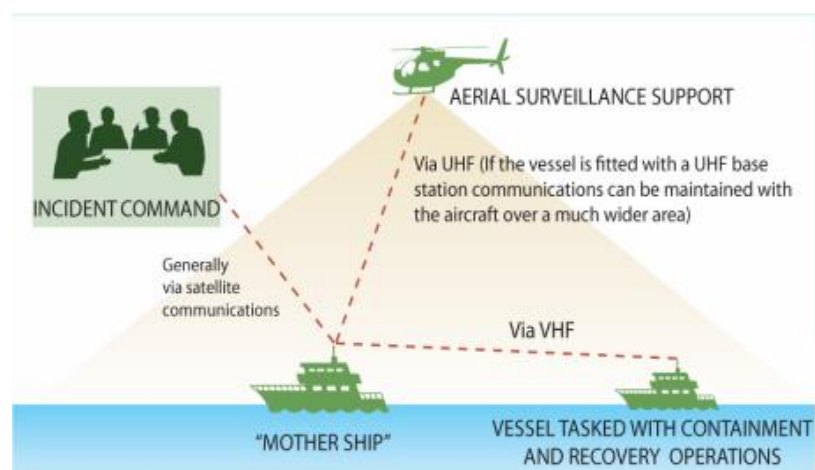


Figure 9. Organizing oil spill response operations

But only usage availability of satellite remote sensing methods in Azerbaijan has been analysed in this article [4]. There are different remote sensing methods like radar, optic, laser fluorosensor, microwave radiometers, ultraviolet imaging, etc. which are used according to effectiveness in the oil spill condition. For example, radar methods are very effective during night oil spill response operations and they have other advantages as well [5].

Services of Azercosmos OJSCo can be used for surveillance, modelling and visualisation activity during oil spill response. Azercosmos was established on 3 May 2010 and it is the only satellite operator in the Caucasus and fully owned by the Republic of Azerbaijan. Azercosmos launched Azerspace-1, the first-ever satellite of Azerbaijan, on 8 February 2013 and Azerspace-1 plays a very important role in connecting more than 50 countries in Central Asia, Europe, Africa and the Middle East. Azercosmos took over the rights to operate and commercialize Azersky which has 1.5 high resolution on December 2014. Also, Azercosmos, launched its second telecommunications satellite Azerpace-2 on 25 September 2018 in a geostationary orbit 45° East longitude [6].

Since Azercosmos is able to take aerospace photos itself, analyse and proceed the photos by its specialised staff and has cooperation with other international companies such as MDA, Canada, these all factors allow Azercosmos help to support in surveillance, modelling and visualisation activity during oil response operations.

Therefore, in case of accident, Azercosmos can provide aerospace photos in Tier 1, 2 and 3 oil spill accident. Moreover, the specialised company “Briggs Marine Environmental Services”, the UK which operates in Azerbaijan can also support the Azerbaijani government to minimize the impact of the oil spill.

Moreover, Azerbaijani specialists also have enough experience in oil spill detection by remote sensing methods. For example, “Investigation of variation by the impact of oil products in the Azerbaijani sector of the Caspian Sea by radar system” project implemented by A. Sh. Mehdiyev, B. M. Azizov, A. N. Badalova, J.A.Sultanov, J.S.Mehdiyev and others are one of the aerospace successes of Azerbaijan [7].

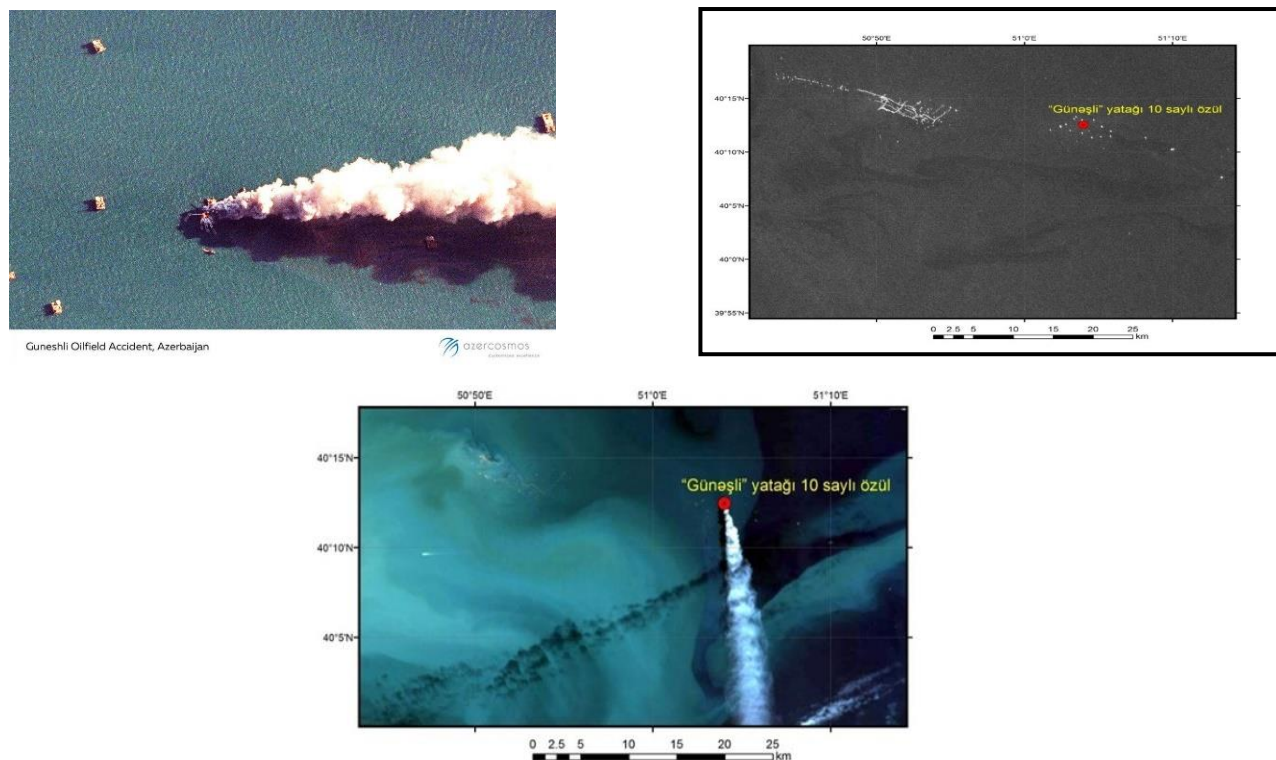


Figure 10. Photos from Azercosmos' archive during accident in Gunashli Oilfield

## CONCLUSION

Preparing Tiered Preparedness and Response plan is very important especially for oil and gas producing countries, even for the countries neighbouring with those oil and gas producing countries in order to prevent local, regional and global

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disasters. Having a good and regular tested response plan will help to save more human life, protect the environment and save the money which is spent on oil and gas clean-up and compensations. All of the factors which characterize a particular situation should be focused on while setting boundaries between tiers and establishing tiered capabilities. It should be also noted that depending on the risks the definition of individual tiers is flexible.

- Tier 1 events usually happen in a small and local area and those events may be managed by local resources and by the operator.
  - Tier 2 events are more complex and require the involvement of many stakeholders and more amount of dispersants, number of equipment and technology. And the event is managed collaboratively with different stakeholders.
  - Tier 3 events happen rarely and when happen they cause very serious damage to the environment and people globally.
- Considering Azerbaijan has its own resources such as remote sensing technologies, dispersants, oil spill response plans and centres, competent responders, etc., in case of any Tier oil spill accident we should be ready to localise the accident, prevent risks to human life and the environment and international penalties [8]. Therefore, regular both theoretical and practical training and simulations should be conducted and incomplete resource relating to response operation should be allocated. Moreover, special volunteering organisations consisting of trained volunteers should be created for involving more help in order support competent responders.

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## IDENTIFICATION OF FACETED NANOISLANDS DURING IRRADIATION IN THERMOELECTRIC MATERIALS BASED ON $\text{Bi}_2\text{Te}_3$ .

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### ABSTRACT

Using the AFM method, we examined the (0001) surfaces of  $\text{A}^{\text{V}}_2\text{B}^{\text{VI}}_3$  crystals before and after irradiation, which are associated with the formation of interlayer nanostructures, the nature of faceted nanoislands (NI). The fractality of nano-objects formed was studied, resulting in the formation of nanoislands on various scales.

**Keywords:** faceted nanoislands, fractality, pores, nanowires,  $\text{Bi}_2\text{Te}_3$ .

### INTRODUCTION

The broad concept of thermoelectric materials based on  $\text{Bi}_2\text{Te}_3$  is distinguished not only by the defect structure, but also by practically important physicochemical properties. Bulk defects are structural disorders that include macroscopic associations of point defects (pores, voids, inclusions of groupings of particles of another phase, crystalline inclusions of groups). The formation of defects is a reaction of crystals to external influences. Pores can be macrostep and nanoislands as evidenced by the cited nanoislands, nanowires, and corrugated structures, dislocation centers. Nanoislands, nanowires, nanorods and corrugated structures, dislocation centers play a decisive quantum-mechanical role in localizing and transferring charge and heat in  $\text{A}^{\text{V}}_2\text{B}^{\text{VI}}_3$  type layered crystals [1]. It should be noted that all nano-formations: NI, terraces of echelons, dislocation reliefs formed between quintets are part of the surface (0001), i.e. they are vertically grown interlayer nanoobjects on the base plane. The purpose of this article is to establish a film growth model taking into account coalescence and orientation of islands, leading to the beginning of the creation of a closed concept of this phenomenon.

### Coalescence in interlayers of $\text{A}^{\text{V}}_2\text{B}^{\text{VI}}_3$ -impurity system

For simplicity, the methods of merging islands of a new phase on a substrate are usually reduced to two main types: liquid-like (like two drops of liquid) and solid-phase (like sticking two solid bodies). The main problem in the theoretical description and coalescence (fusion) of islands lies in the nonlinearity and even nonlocality of this process in the space of dimensions [4]. With the growth of films of some materials, coalescence leads to a percolation transition. At the stage of coalescence, the structure of the growing film is formed; therefore, by controlling the coalescence, one can control the structure and some properties of nanostructured crystals. Nanoislands in  $\text{A}^{\text{V}}_2\text{B}^{\text{VI}}_3$  can be detected by scanning atomic force microscopy. Electron irradiation of crystals leads to the formation of point defects [2]. The p-type  $\text{Bi}_2\text{Te}_3$  is a highly defective crystal with a relatively small Hall mobility of charge carriers, so the irradiation introduces additional defects. Irradiation can change the density of states in this zone. In the initial sample, the main type of defects is anti-structural, that is, Bi is in the Te positions, which gives a high initial hole concentration.

### Experimental results and their discussion

X-ray diffraction studies of the (0001) surface were carried out on a Philips PANalytical (XRD) diffractometer. Point defects interacting with linear structure defects create bulk pores of various types. It is advisable to refer to the pores  $\text{A}^{\text{V}}_2\text{B}^{\text{VI}}_3$ -Te volume inhomogeneities - three-dimensional clusters of vacancies (available in sufficient quantities in  $\text{Bi}_2\text{Te}_3$ ). The chemical components from which an island phase is formed can diffuse to it in various ways. One of the components can enter the surface of an island through surface diffusion, and the other due to diffusion in the gas phase. In the case of the growth of islands on the interlayer surface, their speed is determined by the intensity of the substance supply and the intensity of heat removal from their surface. The above was confirmed by AFM images on a 2D scale of the phase surface in  $\text{Bi}_2\text{Te}_3$ . Interest in the study of physical processes in interlayer island systems is supported mainly by the fact that they are a source of important information about the nature of the interaction between atoms migrating over the (0001) surface of the crystal and elements of the real structure of pore patterns (Fig. 1) with nanoscale parameters. The formation of NI (or rather clusters) in

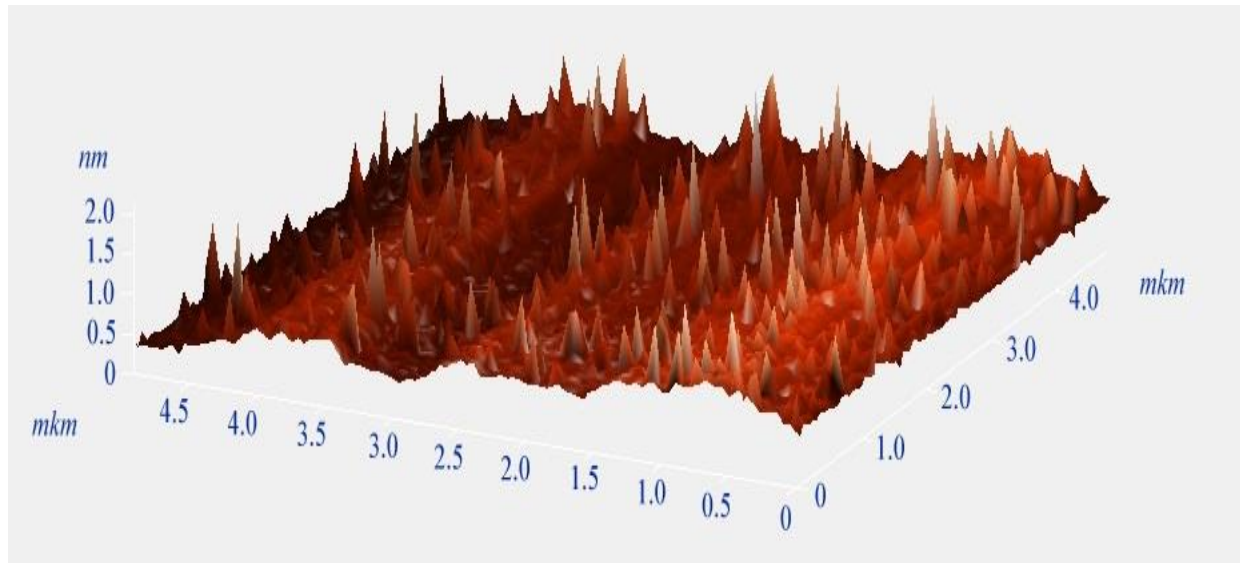


Fig.1. Formed nanoislands in the places of nucleation of pores on the (0001) surface of  $\text{Bi}_2\text{Te}_3$ .

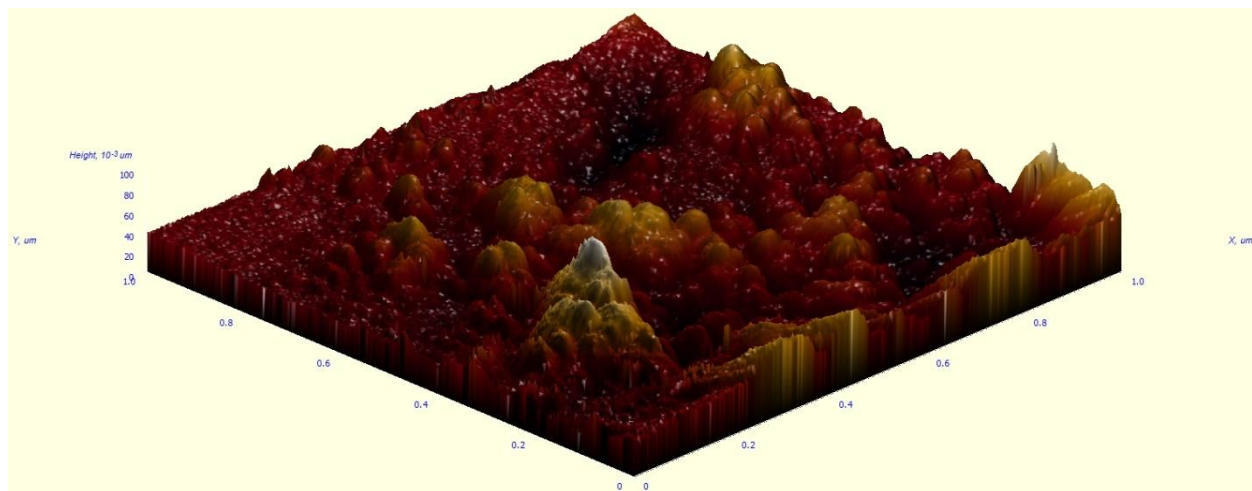


Fig.2. Formation of faceted nanoislands on the (0001)  $\text{Bi}_2\text{Te}_3$  surface after 30 Mrad irradiation.

the pores studied is illustrated in (Fig. 1). The appearance of NI is an extremely important process in the scattering of electrons and phonons during the formation of nanostructured materials. This applies, for example, to the formation of hexagonal pores and NI in them on the van der Waals surface (Fig. 1). It is possible that in the process of crystal growth under certain critical conditions described in, a certain part of the crystal lattice is destroyed and in their place, ordered NI shown in Fig. 1 are formed and localized. At the same time, NI of different heights at the base acquire the configuration of nanopores. At the same time, the minimum critical size of a nucleus in a pore is determined by the thermal dynamics of nucleation and the initial concentration of atoms forming a cluster in the pore space. With increasing pore size, several smaller clusters are formed in it. Comparing the morphology of the surface of the phases that make up the  $\text{Bi}_2\text{Te}_3$ -Te eutectic before and after irradiation of the absorbed dose of 30 Mrad. We see that in Fig. 2 of the above processes, mutual

collisions of islands may also occur, accompanied by their diffusion fusion. Experiments on the growth of nanoobjects show that the shape of embryos on the surface changes during their growth. It is either cut or, on the contrary, becomes unstable. Faceted nanofragments form when atoms are intercalated onto the (0001) surface of layered crystals[5].. Under conditions of dislocation diffusion, the growth of islands occurs at the stage of Oswald ripening. In the process of detachment from dislocations, islands in the process of maturation begin to be faceted. As the shape of the cut increases, the speed significantly decreases [3]. Irradiation, as can be seen from Fig. 2, changes the phase composition, which is associated with the outflow of radiation defects along the interface.

## CONCLUSION

From general considerations, it follows that under the influence of radiation defects, the nanostructure can either be amorphized, or, conversely, facilitate removal due to the presence of numerous interfaces. The mechanisms of NI formation on the (0001) surface of  $\text{Bi}_2\text{Te}_3$  at the stage of Ostwald ripening is a model for studying the processes of formation of self-organized nanoobjects on the (0001) surface of layered structures. Interest in the study of physical processes in interlayer island systems is supported mainly by the fact that they are a source of important information about the nature of the interaction between atoms migrating along the (0001) surface of a crystal and elements of the real structure of pore patterns. The sequence of processes of coalescence of vacancies and coagulation of small pores in  $\text{Bi}_2\text{Te}_3$  leads to enlarging of pores.

It should be noted that the process of the emergence of macroscopic pores due to the coagulation of excess vacancies occurs simultaneously with the process of healing distortions, which are also “drains” for excess vacancies.

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## THE IMPLEMENTATION OF MANUFACTURING AGENT'S CONCEPT FOR FLEXIBLE PRODUCTION SYSTEMS

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### ABSTRACT

The proposed report provides the analyzes of modern concepts of flexible integrated manufacturing systems (FIMS), that have essential effect for simulation and practical implementation of modern production control systems. There is considered the structure and functioning specifications of FIMS, of their control systems. As a improving tool there is overviewed the concept of intellectual manufacturing systems and multi-agent's approach to their implementation.

**Keywords:** decision-making, manufacturing agent, robotics, flexibility, integrated system.

### INTRODUCTION

The research, development and application of flexible integrated systems (FIS) is one of features of humanity entrance to the post-industrial stage of development. Application of FIS must provide the quick and low-cost transition to the new production types output, especially for conditions of low-series production. The efficiency of FIS is determined by optimal organization of technological equipment usage, supplied by robotized and transport systems, delivering bars, details and instruments, making the required service and check of technological processes.

The mass use of FIS becomes effective only then, if with the society demand for their application, the level and culture of production reach the certain quality level. Commercially viable development, introduction and exploitation of FIS's and robots are still quite expensive and not possible and every factory in any country. Recent Fukushima nuclear power station disaster, also earlier accident on oil platform in Mexico Gulf have shown, that even the most developed countries have level of robotics, which doesn't correspond the modern current needs of technical tools application in dangerous human conditions.

From the moment of Chernobyl disaster time in some aspects robotics haven't moved forward and the absence of required technical and informational supplement again lead to human resources using during quite simple tasks execution (investigation, transport operations, cleaning of territory with radioactive dirty) [1]. Therefore, the level of technical, technological and informational supplement of modern FIMS is in-corresponding to public challenges and asks for increased attention from theorists and practices. The mentioned makes researches in this field one of most perspective in modern science and technologies.

### The analysis of FIS Applications

Flexible integrated manufacturing systems (FIMS) are considered as the method of production organization, which supplies the total control of production process and assumes the incorporation of NPC-machines and other technological equipment by local computer network to unite the threads for details processing or assembling, application of cutting instruments, other supplement and corresponding information streams [3].

The analyzes of FIMS shows, that the robot's AI is mainly implemented by computer system, which controls the robot manipulator's movements or his mobile platform. The AI of robots is based on highly developed sensor system, which includes the technical vision systems of different types, sensors of tactile type, meters of distance, gyroscopes, compasses, sensors of color etc. In addition, apart from the recognition of scenes and tactile sensing speech recognition and natural speak processing have important role for FIMS intellectualization [5, 6].

The integrated automated manufacturing must include the in-built artificial intelligence tools, which supply the optimization of whole FIMS taking in account the overall cost of operations and resources. In this condition the manufacturing ACS have to supply the solving for the next problems: [6]:

- optimal application of instruments and equipment;
- minimization for details displacement and for billet storage level;
- minimization for machines and robots downtime;
- maximization for rate and output volume of production;
- minimization for production costs by materials and tools flows checkout;
- Computation of safe transition paths for systems of robots and interacting robocars with supplement.

The industrial robots need such AI-tools, which give possibility for self-education on base of collected data's on machines timeouts and declining of their characteristics, for response to emergency situations (tool breakage, outside objects appearance in workspace) and for required adaptation on manufacturing system functioning. Robot's, able for self-education and estimation of surrounding workspace can become the assistants of human in manufacturing sphere, which doesn't replaces him, but enriches by functions and simplifies the works with instruments, materials and informational flows.

The tendencies analyzes for FIMS development shows the rising complexity of modern manufacturing as for stand-alone work cell as for workshop or factory. For such conditions the role of automated control systems, which applies the AI-methods and are able with sensor systems to get information on state of manufacturing systems, to analyze it and to make decision on functioning of factory. From other hand, the part of manufacturing decisions at every workplace, which becomes the function of supplement equipment: robocars, industrial robots, and other technological and supplement systems?

Therefore, the problem of development and introduction of tools for intellectual decision-making support at different levels of manufacturing control and for particular units of FIMS is still actual.

### Implementations of strategies' planning systems for robotics

The functionality of most of information systems (IS) has purposeful manner. The typical act of such functioning is a decision of planning task by need purpose achievement from fixed initial situation. The result of problem solving can be expressed as plan – the partially ordered sequence of actions. Such plan is similar to scenario, for which vertexes are connected by relations of type "purpose – sub-purpose", "purpose-action", "action-result" etc. Any way in such scenario, which leads from current state to one of vertex purposes defines the plan of actions [7].

The action's plan search task rises then informational system meet non-standard situation, for which there is no known action's set that reaches the purpose. All the tasks of action's plan construction can be divided into 2 typed, corresponding to different models: planning for space of states (SS-problem) and planning for space of tasks (PR-problem) [1].

For the first case the set of situations is given. Their descriptions include the states of surrounding world (workspace) and of Informational system (IS) with corresponding parameters. Situations are combined to generalized states and actions of IC or workspace changes lead to state's changes, actual for current moment of time. Among the generalized states – the initial (usually one) and final (purpose). SS-problem decision is in the search of path form initial state to one of the final.

For the space of tasks planning situation is slightly different. The workspace is created by introduction of relationships like «whole – part», «task – sub-task», «common – partial» etc. Therefore, the task space maps the decomposition of tasks to sub-tasks (purpose – to sub-purposes). PR-problem is in the search of initial task decomposition to sub-tasks, that leads to the tasks with available solutions.

Source [2] contains the classification of methods, used for solving SS- and PR-problems.

1. Planning on states. Presentation of tasks for the space of states includes the following descriptions: states, sets of operators, influences to transition between states and purpose states. States can be described by symbols, one- and two-dimensional arrays, trees, lists etc. Operators transform object form one state to other. Sometimes they have the production view:  $A \rightarrow B$ , meaning the transformation from state  $A$  to state  $B$ .

The space of states can be set by graph with vertexes of states, arcs of operators. If some arc is directed from vertex  $n_i$  to vertex  $n_j$ , then  $n_i$  is son, and  $n_j$  - father vertex. The sequence of vertexes  $n_{i1}, n_{i2}, \dots, n_{ik}$  for which every son vertex for vertex  $n_{ij-1}$  is a path  $k$  from vertex  $n_{i1}$  to vertex  $n_{ik}$ .

Therefore, the task to solve problem  $\langle A, B \rangle$  in planning be states can be presented as search task on graph from  $A$  to  $B$ .

2. Planning on tasks. Such method is effective for hierarchy structure of problem-solving. Planning search for tasks space is in the sequent reduction of initial task to more and simpler up to reaching the elementary tasks. The partially ordered set of such tasks combines the solution of initial task. The partition of task to alternative sets of subtasks can be easily presented as AND/OR graph. In such graph any vertex (apart from end) has conjunction (of type AND) and disjunction (of type OR) vertexes. For particular case, if AND-vertexes are absent, there is graph of state's space. The end vertexes are



finite (corresponded to elementary tasks) or not effective (deadlocks). The initial vertex (the origin of graph AND/OR) is initial task. The purpose of search for graph AND/OR is to show, that the initial vertex has connection to solutions. The solutions are final vertexes (of type AND) for which all the son vertexes can be solved and all OR-vertexes with at least one solved son vertex. The example of implementation of planning method of General Problem Solver – GPS.

3. Planning with help of logical inference. It assumes the description of states as Well-Formed Formulas (WFF) for certain logical computation, operator's description as WFF or translation of WFF to others. The presentation of operators as WFF lets to create the deductive planning methods, the presentation of operators as translation rules – to create the planning methods with elements of deductive inference.

### Manufacturing agents and proposals on it's applications

For case of FIMS adaptivity is a possibility to keep manufacturing system workability for case of functioning condition changes, caused by external (other FIMS, transport system, energy supplement, ventilation system etc.) and internal (work of processing units, NPC-units, transport system, personal activity etc.) sources.

For such conditions FIMS must adapt to the current conditions and change the schedule (plan) for whole system functioning or for some parts, providing the adaptation of functioning strategy.

The technological process of mechanical processing and assembling must be provided in one or several workshops with processing centers, NPC-machines, industrial and transport robots, storages and the transport system.

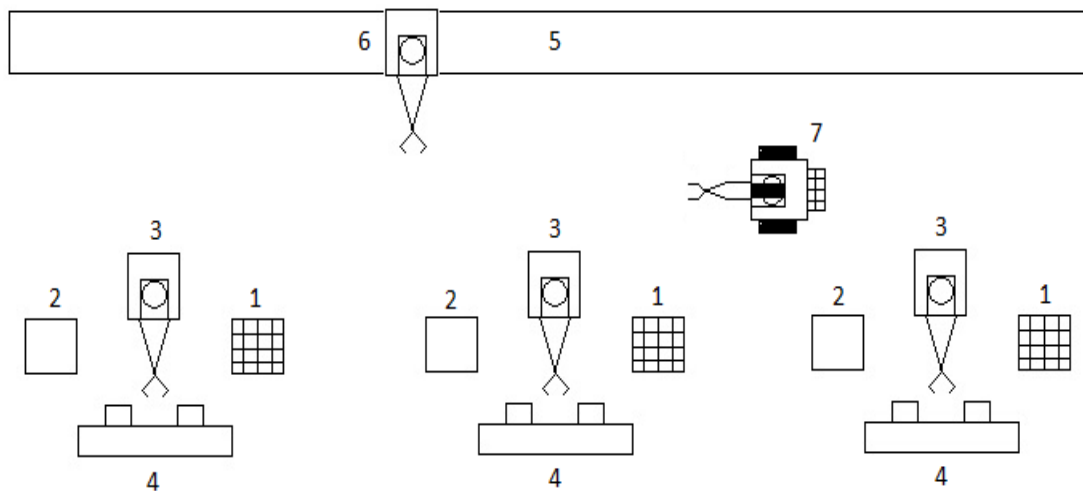


Figure 1 – The structure of flexible automated sector

(1, 2 – input and output storages, 3 – industrial robot, 4 – NPC-machine, 5 – transport system, 6 – transport robot, 7 – intellectual assembling-transport robot)

To supply its functionality the assembling-transport robot must correspond to the following construction demands:

- the presence of mobile platform chassis;
- the presence of manipulator (or of several manipulators);
- the presence of cargo block to transport billets, details, instruments and equipment;
- the presence of communication system;
- the presence of control system with computer on-board;
- the presence of sensor system for chassis and manipulator.

The assembling-transport robot must be selected on base of existing models of transport robots and manipulators.

The particular element of control system for mobile assembling-transport robot is decision-making support system (DMSS). As to dynamics of robot's workspace DMSS must supply the problem-solving for transition tasks of assembling-transport robot to particular workspaces, to schedule the loading-uploading operation for technological equipment, instruments and supplement, to plan some assembling operations. The dynamic nature of assembling-transport robot workspace, determined by particular production system, defined the demands of functioning strategies adaptivity, which must supply the increase stability and productivity of flexible manufacturing systems.

## CONCLUSION

The proposed work provides the analyzes of modern concepts of flexible integrated manufacturing systems (FIMS), that have essential effect for simulation and practical implementation of modern production control systems. In particular, there is considered the structure and functioning specifications of FIMS, of their control systems. As a improving tool there is overviewed the concept of intellectual manufacturing systems and multi-agent's approach to their implementation. As an example of manufacturing agent's concept practical implementation the functioning of industrial and transport robots is proposed. Robots, unlike the logical agents, are the real material objects of physical world and, actually, the physical agents. Because of that, robots are supplied by different execution tools of manipulation type, by sensor systems to measure the workspace parameters. Some robots are mobile and able to move on workspace. The real robots act in conditions when the workspace is only partially determined, stochastic, dynamic and continuous. For the most of real cases, the robot's workspace is multi-agent and sequential.

Therefore, the speed and quality of functioning strategies planning for FIMS is defined by selection of methods of data search for intellectual robotized system. The strategies planning correspond to the multi-stage decision-making models. The functioning strategies planning for FIMS can be described by a number of states and tasks with fuzzy and probabilistic methods application. During development of functioning strategies planning systems of FIMS the subject of essential attention is simulation of robot's and surrounding objects workspace. The systems of strategies planning can be practically implemented as action planning systems and correspond to the concept of manufacturing agent.

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## EFFECTIVENESS OF USING GAMES IN TEACHING GRAMMAR

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### XÜLASƏ

Qrammatikanın tədrisinin əsas məqsədi tələbələrin ingilis dilində düzgün danışmasına kömək etməkdir. Tələbələr ingilis dilini aydın və düzgün quruluşla öyrənərlərsə, gələcəkdə yaxşı ünsiyyət quracaq və yaxşı həmsöhbət olacaqlar. Qrammatika olmadan yalnız məhdud vəziyyətlərdə effektiv ünsiyyət qurulur. Bundan əlavə, qrammatika dil və ideyaların öyrənilməsinin çox vacib hissəsi hesab olunur. Əslində, qrammatika insanlara dilini təhlil və təsvir etməyə kömək edir. Bu yollardan biri də qrammatikanı oyunlarla öyrətməkdir.

**Açar sözlər:** İngilis dilinin qrammatikası; qrammatik tədrisə yanaşma; ikinci dilin inkişafı; oyunlar

### РЕЗЮМЕ

Основная цель преподавания грамматики - помочь учащимся говорить по-английски с организованными и правильными структурами. Если студенты изучают английский язык с четкими и правильными структурами, когда они молоды, в будущем они станут хорошими коммуникаторами. Без грамматики можно эффективно общаться только в ограниченных ситуациях. Кроме того, грамматика считается очень важной частью изучения языка и идей. На самом деле, грамматика помогает людям анализировать и описывать свой язык. Один из этих способов учить грамматику играми.

**Ключевые слова:** английская грамматика; грамматический подход; развитие второго языка; игры

### INTRODUCTION

Games are regarded as very useful and important strategy to stimulate language acquisition. They are defined as a form of play concerning competition, rules and fun. So, teachers should use games in teaching to attract students' attention, decrease students' stress and give them the opportunity to communicate effectively. They increase students' proficiency. That is, playing games in the classroom can increase students' ability in using language as students have an opportunity to use language with a purpose in the situations provided.

The main goal of teaching grammar is to help students speak English with organized and correct structures. If students learn English with clear and right structures when they are young, they will be good communicators in the future. Without grammar, students are able to communicate effectively only in limited situations. Besides, grammar is regarded as very essential part of the study of language and ideas. In fact, grammar helps humans to analyze and describe their language.

**Games are regarded as very useful and important strategy** to stimulate language acquisition. They are defined as a form of play concerning competition, rules and fun. So, teachers should use games in teaching to attract students' attention, decrease students' stress and give them the opportunity to communicate effectively. They increase students' proficiency. That is, playing games in the classroom can increase students' ability in using language as students have an opportunity to use language with a purpose in the situations provided.

**Games can focus on various skills**, grammar, listening, speaking, writing, reading, pronunciation, so they can be extremely complex. Games also help the teacher to create contexts in which the language is useful and meaningful. 'Games provide one way of helping the learners to experience language rather than merely study it.' (Wright et al., 2006: 2). When exposed to language, students acquire it better. For example, words related to shopping can be better practiced in actual shopping games, than using worksheets with exercises. Games also offer the possibility of repeated use of language items. By making language convey information and opinion, games provide the key features of 'drill' with the opportunity to sense the working of language as living communication. Thus, learning is better absorbed than learning based on mechanical drills (Hadfield, 1990).

**Games must not be seen as a way of passing the time**, because their purposes are multiple. Besides the major importance of games of spurring motivation and reducing the stress level in the classroom, games have a great advantage in the sense that students learn without knowing they are learning (Hadfield, 1990). During games, students do not worry much about grammar mistakes, they are focused on what they are trying to convey. Apart from having fun, they will learn a grammatical rule just by playing an appropriate game. 'Students stop thinking about language and begin using it in a spontaneous and natural manner within the classroom.' (Mubaslat, 2012)

**Playing games in the classroom** can enormously increase students's ability in using language because they have a chance to use it with a purpose and in the situations mentioned. Naturally when playing games, students are trying to win or to beat other teams for themselves or on the behalf of their team. They are so competitive while playing since they want to have a turn to play, to score points and to win. In the class, learners will definitely participate in the activities. Therefore, in groups or in pairs, they are more willing to ask questions, communicate and discuss with their partners and think creatively about how to use English to achieve the goal. The competition in the games gives students a natural opportunity to work together and communicate in English with each other a lot.

**Games are student-focused activities** requiring active involvement of learners. In Crookal's (1990) opinion, learners and teachers change their roles and relations through games and learners are encouraged to take active role in their learning process. As a result, games provide learners with a chance to direct their own learning. From an instructional view point, creating a meaningful context for language use is another advantage that games present. By using games, teachers can create contexts which enable unconscious learning because learners' attention is on the message, not on the language. Therefore, when they completely focus on a game as an activity, students acquire language in the same way that they acquire their mother tongue, that is, without being aware of it (Cross, 2000, p. 153).

**Games allow for creativity**, independence and higher order thinking. Usually, questions posed by the classroom teacher are fact based and have only one answer, not allowing for creativity, personal expression, or testing hypotheses. The answer is either right or wrong, but games can allow for multiple answers. They improve participation, self-esteem, and vocabulary usage and allow the learners to see that there are many ways to solve the same problem.

**According to Crystal** (2004, p.123), "Grammar is the structural foundation of the ability to express ourselves. The more we are aware of how grammar works, the more we can monitor the meaning and effectiveness of the way we and others use language. It can help foster precision, detect ambiguity, and exploit the richness of expression available in English."

**Vernon** (2008:1) mentioned four reasons to teach grammar with games: First, by using games in teaching grammar, students not only gain knowledge but also can apply and use what they learn. So, games are regarded as communicative activities. Second, it is obvious that fun learning games usually contain repetition, which make the language easier and understandable by students. Third, using games motivate students and increase the cooperation and competition in the classroom and this creates positive atmosphere. Fourth, learning a new language requires a great and tiring effort. Games facilitate the matter because they are amusing and challenging and they allow meaningful use of the language in context. "Games enhance repetition, reinforcement, retention and transference" (El-Shamy 2001: 10). Because each game has a specific learning objective in mind, each player's turn deals with the same concept or skill in a different way. Therefore, what students do not learn on their own turn, they may grasp from someone else's turn. Moreover, the responsibility for learning and practicing is the job of the student and it is willingly accepted.

Yu (2005:34) pointed out that:

Games have different characteristics such as:

- A game involves a challenge against either a task or an opponent.
- A game is governed by a definite set of rules.
- A game is freely engaged in.
- Psychologically, a game is an arbitrary situation clearly separate from real-life.
- Socially, the events of a game situation are considered, in and of themselves, to be of minimal importance.

- A game has a definite number of possible solutions; that is, only a finite number of things can happen during play.
- A game must always end, although the end may come simply because time has run out.

Summing up, the basic characteristics of games in general are:

- A game is fun and interesting
- A game is rule-governed
- A game is goal defined
- A game is engaging
- A game is competitive
- A game has a closure

**According to Deesri (2002:2)**, when teachers want to choose certain games to be played in the class, they should first consider the games' purpose, students' characteristics whether they are old or young, and the suitable time of playing the game. Some games should be used in the morning, others in the afternoon and others on Friday.

**The use of innovative educational games** in the classroom can increase enthusiasm and reinforce previously presented didactic information. It is also a positive, interactive alternative method of teaching and information sharing. In addition, team learning and active peer-to-peer instruction are strongly reinforced by educational games.

**Games increase** students' involvement, motivation, and interest in the material and allow the instructor to be creative and original when presenting topics. Games also challenge students to apply the information, thus allowing them to evaluate their critical thinking skills. They create a challenging constructively competitive atmosphere that facilitates interaction among students in a friendly and fun environment.

**Games have a great pedagogical value** providing language teachers with many advantages when they are used in foreign language classes. The review of the studies related to language games indicates that games are crucially important in foreign language teaching and learning in a variety of areas. Games in teaching grammar to the young learners not only can play a positive role in the development of grammar knowledge of the learners in the language classes but also it can pave the way for language development of the learners in a stressed situation, motivating the learners to improve their own abilities in various aspects of second language development.

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## ROUTE SEARCH METHOD USING ARTIFICIAL INTELLIGENCE METHODS

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### ABSTRACT

Choosing a route in special purpose networks with the ability to self-organize on the basis of specific parameters is the main problem for the protocols of dynamic routing of special purpose networks, as well as the difficult task of climbing the network. In this paper, we propose a method for searching the route, for many parameters based on fuzzy logic (FL) and the modified ant colony system (ACS) system, which searches and maintains the path of the packet passing between two points, the node from which the IP packet and the node are sent destination (NS / ND). When looking for a route, the following parameters are taken into account: the energy component (EP), the speed of data transmission, the time delay of the IP packet from the node sending the packet to the destination end-to-end delay and the reliability of the delivery of the IP packet. In this system, online traffic data collects directly from packets transmitted over the network, and further traffic data are predicted using artificial neural networks (ANNs). When collecting information from packages that carry information about the routes filled knowledge base. Unlike the usual dynamic routing protocols, the parameters for which the route search is performed is dynamic, which results in the automatic adaptation of the route search algorithm to the network state. The proposed method is intended for use in networks of special purpose with the possibility of self-organization.

**Keywords** - Fuzzy logic, protocol, routing, system of ant colonies, artificial intelligence, network, multiparameter.

### INTRODUCTION

In route selection tasks, as a rule, a couple of nodes sends an IP packet and an IP packet destination node (NS / ND), while there are many possible routes to select. The goal is to find the route with the lowest cost, based on the cost, calculated for different possible directions.

Some modern protocols for dynamic routing in special purpose networks have built-in algorithms for finding the route, which try to minimize the cost of delivery of packets from the destination node to the destination node. However, the specifics of the use of special-purpose networks require the development of new routing methods and techniques, taking into account a plurality of parameters to ensure the delivery of data from the sending node to the destination node.

Finding the shortest path (less cost) between a pair of points is a complex problem, which requires a calculation of all possible routes. In addition, most users now need not only routes with the least number of hops to the destination, but routes that can meet other important requirements. Such users most often need to provide support for the power component to increase battery life, to take into account the speed of the communication channel, the delay time for delivering the IP packet between the sender node and the destination node, and the reliability of the IP delivery of the package by the route.

Known scientific research does not take into account all these important parameters in one search and maintenance route in special purpose networks with the ability to self-organize. In turn, the system of ant colonies, combined with fuzzy logic, is used in the modified dynamic routing protocol (DSR) algorithm (DSR). The modified algorithm is designed to reduce the number of service packages when searching for a route. So in the second section we analyze the methods of information processing. In the third section of this paper, we will describe the use of fuzzy logic in the combination of the neural network. In the fourth section of this paper, a modified system of ant colonies is presented for solving the problem of the Survivor.

### Using Fuzzy Logic in Dynamic Routing Protocols

One of the most significant limitations of fuzzy output systems is the difficulty of building a knowledge base with more than five factors under consideration, provided that more terms are used to describe the factor. The generalization of the analysis of information processing methods is presented in Table 1.

1-ci Beynəlxalq Elmi-Praktik Konfrans:

Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

Table 1 - Generalization of the analysis of information processing methods.

Name of the method	Brief description	Subhead
Factor analysis	Balance assessment of factor sets, score estimation of sets of levels of factors values, the definition of a general assessment taking into account the works of factors on their significance level	The need for experts to assess the factors and levels of their significance, the complexity of accounting factors that have a nonlinear impact on the overall assessment, the complexity of the processing of information in a verbal form
Spectral analysis	Representation of the initial value of the function of the investigated process in the form of a set of sinusoidal components, which allows to detect hidden cycles in the development process	The need for a significant sample of values of the output process for building its graphical dependence, the focus on the processing of information presented in numerical form
Neural Networks	Construction of a mechanism for determining the output variable based on the input factors due to the correction of the values of the synapse weights (edges) of the network	The complexity of the processing of verbally described information, the secrecy of the network learning process, the need for a sufficient number of examples used for training the network, making it difficult to adjust the network during its operation
Delphi method	Obtaining a generalized assessment on the subject under consideration by the expert group	Dependence of the result on the opinion of experts
The theory of fuzzy sets	Summarization of information provided in numerical and verbal forms through the use of the representation of input variables in the form of fuzzy numbers, with the subsequent compilation of knowledge base on product rules.	The complexity of the formation of knowledge base with the account of more than five factors about the object being studied

Summarizing the analysis and taking into account the analysis of work on information processing [1-12] the most expedient is considered the choice of methods of the theory of fuzzy sets for the processing of factors and for the evaluation of information, since its application allows us to develop a mechanism for processing information, takes into account the mutual influence of verbally and numerically described factors, presented in various assessment scales.

#### Fuzzy logic and artificial neural networks

A fuzzy logic system is a popular and powerful tool that is being implemented by researchers for optimal route selection. Considering the problem of finding a route as a multi-criteria problem, [13] presents various approaches to optimizing the

search process and making decision choosing a route using fuzzy sets and fuzzy logic.

The basis of fuzzy logic that was initiated by the American scientist Lotfi Zadeh [10, 11] allows us to describe qualitative inaccurate concepts and knowledge about the surrounding world. The methods of constructing information models based on this theory substantially expand the scope of application of information systems. Ibrahim Mamdani [10, 11] is one of the first scientists who developed the concept of fuzzy control to manage complex processes, especially when there is no clear model for describing processes [10, 11]. Fuzzy management can be described as a means of controlling work with conditional sentences, which are called linguistic rules "IF-TO", rather than mathematical equations. The derivation of the rule is called the conclusion and requires the definition of the membership function that characterizes this conclusion. This function defines the degree of truth of each sentence [14].

The various stages of a simple fuzzy logic control system are as follows:

- formation of the rules base of fuzzy output systems;
- phasification of input variables.

Each fuzzy system is implemented in the form of fuzzy rules (1), such as

Rule I: If A is  $p_1$  and B is  $q_1$  then Z is  $g_1$

Rule II: If A is  $p_2$  and B is  $q_2$  then Z is  $g_2$  (1)

Where A and B are variable parts of the condition, Z is a part of the action variable, and p and q are fuzzy parameters characterized by membership functions. Some rules of the rules of control use measurements, which are usually valid numbers [14].

$$R = \bigcup_{i=1}^n (R_i \cap R_j) \quad (2)$$

Where "∪" disjunction is the "max" function when used with the example of Mamdani.

- dephasing is a fuzzy result that is the result of the conclusions, becomes a real value, which can be used as a control input. Since the desired output is an indeterminate result, the quantitative value of the control output is determined

by dephasing  $\mu_{g_i}(R)$ . There are two general methods of defazification, which are the "center of gravity" and "average maximum" methods.

In artificial neural networks, the mathematical model simulates biological neural networks of the brain. A brain model connects many linear or nonlinear neuron models and processes information in a distributed distributed manner. Since neural networks have training and self-organization capabilities, they can adapt to data changes and learn the characteristics of the input signal. Such networks can study the reflection between the input and output space and synthesize associative memory, which receives the corresponding output when it is presented with the input and is generalized when represented by new inputs [12]. Neural networks are used today in many industries, including recognition, identification, broadcasting, vision and control systems [13].

A neuron with an input vector with one n-element is shown in Fig. 2, where  $p_1, p_2, p_3, p_4$  include separate elements and  $w_1, w_2, w_3, w_4$  are the weights of the joints. An artificial neural network can be taught to perform a function by adjusting the weight values [13]. The block of the neuron has a displacement, which is summed up with the weight inputs to form a clean input. The output of a neuron is a weighted sum of input signals

$$y = f\left(\sum_{i=1}^n w_i p_i + \theta\right) \quad (3)$$

The activation function of neurons is often a continuous and nonlinear function called a sigmoid function and is defined as

$$f(x) = \frac{1}{1 + e^{-ax}} \quad (4)$$

where e- constant and  $0 < f(x) < 1$

1-ci Beynəlxalq Elmi-Praktik Konfrans:

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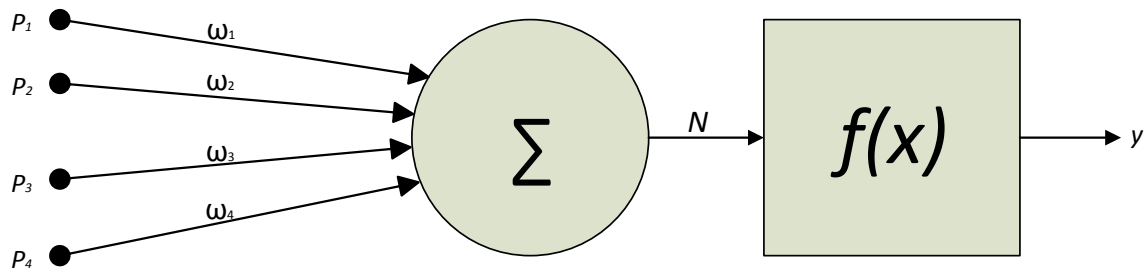


Fig. 1: Model of artificial neuron.

One of the most commonly used categories of artificial neural networks is called a direct network. This hierarchical structure consists of several layers without interconnections between the neurons in each layer, and signals come from the input layer to the output layer in one direction, as in Figure 3.

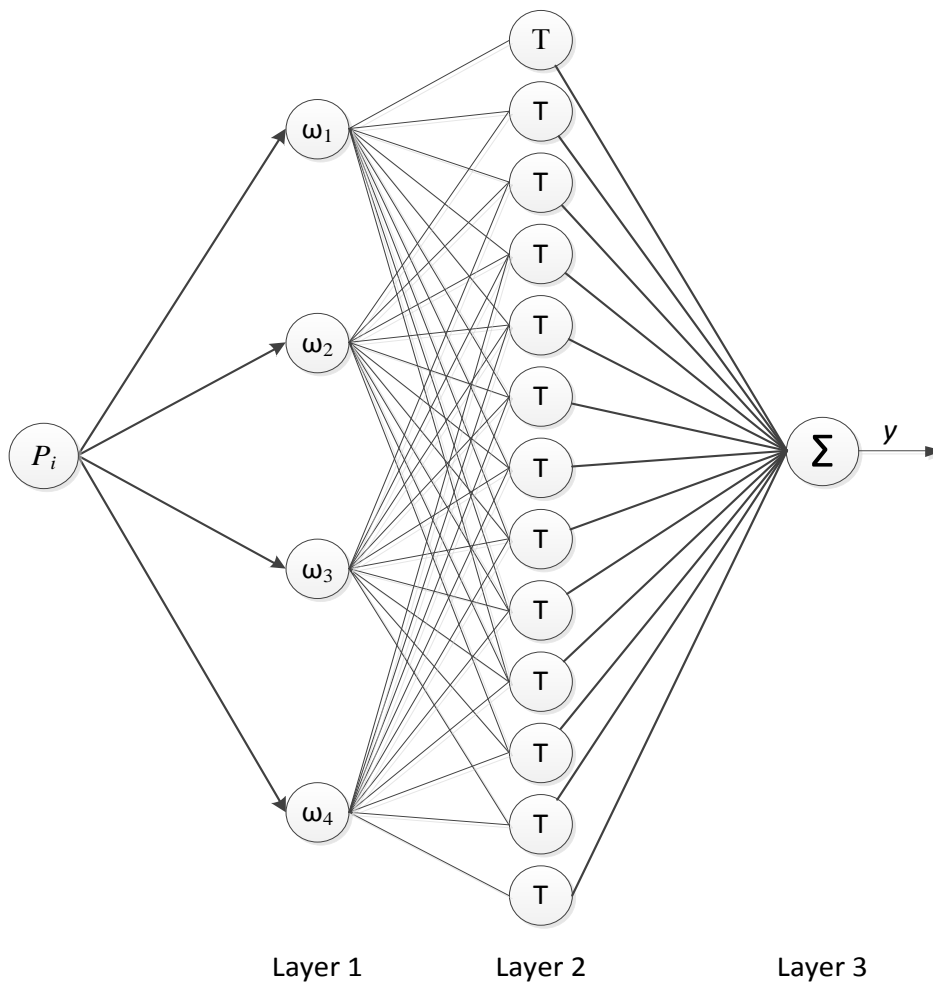


Fig. 2. Structure of a fuzzy neural network of one parameter for choosing the concentration of pheromone.

The first layer of the neurons performs the procedure of phasation, that is, bringing to fuzzy. As a result of this procedure, the values of the membership functions for the input variables are calculated. In order to ensure the maximum speed of the neuro-fuzzy data flow management system, it is proposed to use parametric, normal, unimodal and triangular membership functions. Given the different nature of the input and intermediate linguistic variables, the function of belonging is built separately for each variable.

The second layer performs the function of aggregation of the degrees of truth of the conditions for each rule of the fuzzy output system in accordance with the operation of the T-norm, in which we use the operation min-conjuncture [13, 18, 22]. As a result of this procedure, the "cut off" levels are determined for the conditions of each of the rules. Those rules whose degrees of validity are different from zero are considered active and used for further calculations.

The third layer of neurons forms at the output of the network a dephase value of the original value, which is the value of the level of pheromone which leaves behind an ant. As a method of dephasing in the Mamdani algorithm, a variant of the center of gravity method is used.

### Mural system of colonies

In [13], authors use ant-algorithms to find the route, and these algorithms are effective in solving the salesman's task.

The Ant Colony System (ACS) is a class of algorithms, the first term called the Ants System (AS), originally proposed by Dorigo et al. [13]. Although these ants are blind, they are able to find the shortest way from the food source to their nest, using a liquid substance called pheromone, which they release on the transit route. The strategy of the Ant Colony tries to simulate the behavior of real ants with the addition of several artificial characteristics: visibility, memory and discrete time for the successful solution of many complex tasks such as the problem of a sales agent [14], the problem of vehicle routing (VRP) [15], and the best route search [16]. Despite the fact that in recent years many changes have been made to the ACS algorithms, their fundamental mechanism of behavior, which is a positive feedback process demonstrated by anonymised colony, remains unchanged. Anthropogenic algorithms have many applications, for example, for communication networks [17], electrical distribution networks [28]. There are different stages of the algorithm of the usual system of ants of colonies such as:

- a description of the task schedule;
- artificial ants are moved between discrete states in discrete environments. Since the tasks solved by the algorithm of the automated control system (ACS) are often discrete, they can be represented by a graph with  $N$  nodes and  $R$  routes;
- initialization of the distribution of ants;
- a number of ants are placed on the nodes of origin;
- The number of ants is often determined based on trial and error and the number of nodes in the region.

The rule for the distribution of probabilities of ants

$$P_{ij}^k = \begin{cases} \frac{(\tau_{ij})^\alpha (\eta_{ij})^\beta}{\sum_{h \notin \text{tabu}_k} (\tau_{ih})^\alpha (\eta_{ih})^\beta} & j \notin \text{tabu}_k, \\ 0, & \text{otherwise} \end{cases} \quad (5)$$

The probabilistic transition of ants between nodes can also be specified as a rule of node transition. The probability of passing ant  $k$  from node  $i$  to node  $j$  is given where  $\tau_{ij}$  and  $\eta_{ij}$  the intensity of pheromones and the cost of the route between the nodes  $i$  and  $j$ , respectively. The relative values  $\tau_{ij}$  and  $\eta_{ij}$  are controlled by the parameters  $\alpha$  and  $\beta$ , respectively. These are  $\text{tabu}_k$  unreachable routes (visited nodes) for ant  $k$ .

$$\tau_{ij} = \tau_{ij} + \rho \tau_{ij} + \sum_{k=1}^m \Delta \tau_{ij}^k \quad (6)$$

where  $0 < \rho < 1$  a constant parameter called the evaporation of pheromones, and  $m$  is the number of ants. The amount of pheromone enclosed in the path between the nodes  $i$  and  $j$  is  $k$ , is



$$\Delta \tau_{ij}^k = \begin{cases} Q & \text{if it goes past the route } (i, j) \\ f_k & k\text{-th ants (in the current cycle)} \\ 0 & \text{otherwise} \end{cases} \quad (7)$$

where  $Q$  is a constant parameter and  $f_k$  is the value of the value of the solution found from the  $k$ -th ant.

Stopping procedure - this procedure is completed by reaching a certain number of cycles or the maximum number of cycles between two improvements to the best global decisions.

## RESULTS

An analysis with the analysis of work on information processing [1-23] is considered the most expedient choice of methods of the theory of fuzzy sets for the processing of information evaluation factors, since its application allows us to develop a mechanism for processing information, taking into account the mutual influence both verbally and numerically described factors presented in different assessment scales.

Thus, a method for finding routes with a combination of elements of fuzzy logic with a fuzzy neural network and a system of ant colonies is proposed. This approach allows you to more flexibly use a plurality of parameters to build a path and adapt to their changes. In the future, using the results obtained will be used to develop a method for finding and maintaining routes in special-purpose networks with the ability to self-organizing, taking into account a plurality of parameters and flexible to their change.

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## IMPLEMENTATION OF MOLECULAR-GENETIC DIAGNOSTIC TESTS IN GEORGIA

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### INTRODUCTION

Genomic medicine is an emerging medical discipline that involves using genomic information about an individual as part of their clinical care (e.g. for diagnostic or therapeutic decision-making). Already, genomic medicine is making an impact in the fields of oncology, pharmacology, rare and undiagnosed diseases, and infectious disease. Precision genomic medicine will have a transformative impact on personal health and wellbeing, health economics and national productivity. [1].

Personalised/precision genomic medicine provides opportunities for new approaches to healthcare delivery and comprehensive population health management. For example, it will identify individuals at risk for many diseases and significantly reduce the incidence of these diseases. This will fuel a drive towards personal health optimization, with enormous benefits for individuals, the healthcare system and the national economy. The medical and scientific communities around the world are just starting to seize the opportunities that personalised genomic medicine offer. [2]

Inherited thrombophilia is a genetic disorder of blood coagulation resulting in a hypercoagulable state, which has been suggested as a possible cause of recurrent thromboembolism. Family and twin studies have established a heritable component to venous and arterial thrombosis. For the vast majority of patients, thrombosis is a complex, multifactorial disease caused by a combination of numerous, often unknown, environmental and genetic factors [3].

The field of pharmacogenetics is rapidly expanding into many clinical disciplines, including hematology. Pharmacogenetics is based on the notion that genetic variations influence the clinical outcomes of drug therapies; ie, gene-drug interactions [4]. Numerous clinical studies have sought to address the benefit of VKORC1 and CYP2C9 genotype-based strategies for initiating vitamin K antagonists (VKAs) [5-7]. Three single nucleotide polymorphisms (SNPs), two in the CYP2C9 gene and one in the VKORC1 gene, have been found to play key roles in determining the effect of warfarin therapy on coagulation. A patient's CYP2C9 and VKORC1 genotype can be used in determining the optimal starting dose of warfarin.

Oncological disorders, such as breast cancer has a high prevalence in half of the global population and constitutes 22.9% of cancer in women [8]. The morbidity and mortality rates caused by malignant tumors stands on the second place in Georgia. Breast cancer is the most common cancer not only in Georgian women, but also worldwide. Although the incidence rate is different in various geographical areas. The risk in the general population is on average 1/10 [9,10]. The rate of breast cancer among women in developed and developing countries is 1/12 and 1/22, respectively [11]. Pathogenic mutations in BRCA1 and BRCA2 genes results a hereditary cancer predisposition syndrome, increases the risk of breast and ovarian cancer. Hereditary mutations in the BRCA1 and BRCA2 genes (BRCA1/2) have autosomal dominant inheritance and increase the risk of female breast cancer by 60–80% and ovarian cancer by about 20–40% [12-14].

Prevalence of above mentioned genetic polymorphism very widely in different populations. Due to the fact that these mutations were not investigated in our population, the aim of the study was to estimate the frequency of genetic and allelic variants of point mutations of genes controlling blood coagulation Factors II (prothrombin) and V (proaccelerin) as well as methylenetetrahydrofolate reductase (MTHFR) – enzyme participating in metabolism of homocysteine (prothrombin - 20210G/A; FV Leiden - 1691G/A and MTHFR - 677C/T) and CYP2C9 and VKORC1 genes in Georgian population patients with venous thromboembolism and their effects on warfarin dose requirement. Also to determine the existence of these BRCA1 gene - 5382insC and 185delAG and BRCA2 gene - 6174delT mutations in Georgian women with personal or/and family history of breast cancer and in case of high rate of distribution of above mentioned mutations implement this tests in diagnostic tools.

1st International Scientific-Practical Conference:

Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)

## Materials and methods

1340 unrelated Georgians with thromboembolism and pregnancy complications were genotyped by PCR analyses for detection of inherited thrombophilia (Factor V Leiden (FVL), Prothrombin (PTH G20210A) and Methylenetetrahydrofolatereductase (MTHFR C677T) gene mutations) and also 50 Georgian patients with venous thromboembolism were genotyped for the three single nucleotide polymorphisms (SNPs) of CYP2C9 and VKORC1 genes and were followed prospectively in determining the optimal starting dose of warfarin. Regarding of BRCA gene mutations, 100 Georgian women, from different region of Georgia, under age 40 with the breast cancer and at least one first or second degree relatives who were suffering from breast or ovarian cancers, were genotyped by PCR analyses. Studied gene mutations were detected by the molecular-genetics methods, which implied the following stages:

I. Extraction of genomic DNA: The genomic (nuclear) DNA was isolated from the peripheral blood by a commercially available DNA extraction kit (Pronto Diagnostics).

For the detection of mutation in the extracted DNA, was used Pronto kits (Pronto Diagnostics, Israel) [15], which detects Single Nucleotide Substitution by a single nucleotide primer extension reaction, followed by Enzyme Linked Immuno-Sorbent Assay (ELISA).

II. Identification of mutation stages in genomic DNA

1. DNA amplification by Polymerase Chain Reaction (PCR), Gene Amp PCR System 9700 (Applied Biosystems) and Pronto Amplification Mix;

2. Detection of amplified DNA by gel-electrophoreses

3. Wild type and mutation-positive allele detection by a single nucleotide primer extension reaction using Gene Amp PCR System 9700 (Applied Biosystems) thermocycler;

4. Wild type and mutation-positive allele detection by Enzyme Linked Immuno-Sorbent Assay (ELISA);

5. Data detection by photometer-reader.

The PRONTO Product line is for in vitro diagnostic use and accredited to the highest international quality standards of production including GLP/GMP, EN46001, ISO 9001 and ISO 13485 and is CE certified.

## RESULTS

As a result of our study it is possible to consider Leiden, Prothrombin and MTHFR gene mutations, especially its homozygous form and double heterozygous carriage as an independent high risk factors for development of thromboembolism, pregnancy loss and pregnancy complications in the Georgian population patients.

Table. Distribution of mutations in patients.

Georgian Population	FV Leiden		Pr G20210A		MTHFR C677T	
Valid	Frequency	Percent	Frequency	Percent	Frequency	Percent
Norma	1245	92.9	1286	96.0	747	55.7
Hetero	90	6.7	52	3.9	500	37.3
Homo	5	0.4	2	0.1	93	7.0
Total	1340	100.0	1340	100.0	1340	100.0

In 40 (80%) patients were found \*1/\*1 wild-type variant of CYP2C9 gene in combination with GG or GA genotype of VKORC1 gene and starting daily dose of warfarin in this study group, considering physical constitution and age of patients, were more than 7 mg. Only in one patient was found rare malfunctioned genotype CYP2C9 \*2/\*3 and VKORC1A/A and daily dose of warfarin was 1 mg. This patient had bleeding under observation of 2 mg of warfarin and pharmacogenetic test was performed only after this episode. Alternative, less active alleles CYP2C9\*2 and \*3 were detected in 9 (18%) patients.

Existence of BRCA1 gene mutations 5382insC and 185delAG and BRCA2 gene mutation 6174delT were not detected among studied 100 Georgian women. These results differ from the data of Ashkenazi Jewish and different European and not European populations, where these mutations and especially BRCA1 gene 5382insC mutation were detected in high

frequency.

## CONCLUSION

Distribution of studied polymorphisms in Georgian population and clinically effective dose of warfarin, considering patients' genetic profile, coincides with the recommendations of CPIC. Noteworthy the fact, that generally, Georgian medical doctors prescribe genetic tests to patients when patients have many episodes of thromboembolism (recurrent thrombosis) and the average dose of warfarin is not effective. Although still in its infancy, the field of pharmacogenetics and pharmacogenomics already provides useful clinical information to enhance patient care and offers a growing potential to individualize drug therapy and improve clinical outcomes. Understanding importance of these results will help clinicians and healthcare professionals in successful management of thrombotic disorders by considering molecular-genetic studies, which is the corn stone of development of the personalized medicine depending on genetic individuality.

To the best of our knowledge this is the first study to detect BRCA1/2 three mutations in Georgian women. The results also suggest that for statistically contribution of these mutation to the breast cancer risk, there is a need for studies with larger sample size, to be sufficient for a reliable conclusion to be drawn.

The studies of inherited thrombophilia (Factor V Leiden, Prothrombin and MTHFR) gene mutations showed that they play an important role in development of thromboembolism, pregnancy outcome, complications or loss. Therefore, screening patients for thrombophilic polymorphism will be very helpful. Analysis of genetic risk factors, such as above mentioned mutations, together with life style of patients and environmental factors, has contributed significantly to our understanding of the genetic predisposition to venous thrombosis.

Implementation of molecular-genetic testing techniques in Georgia able and is very important for early detection of inherited risk factors. We intensely inspire the systematic study of both patient and control populations in Georgia for detection different genetic variations and polymorphism.

**Keywords:** Inherited Thrombophilia, gene, mutation, pharmacogenetics, breast cancer, BRCA genes.

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## CLOUD COMPUTING AND E-GOVERNMENT

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### ABSTRACT

Governments around the world are actively looking into cloud computing as a method of increasing efficiency and reducing the cost. Cloud computing has developed a conceptual and infrastructural base for tomorrow's computing. Based on a review of advanced cloud computing we observed that these governments including the United States, United Kingdom, the European Union, and Japan, have taken on several different roles about concerning their approaches to advanced cloud computing strategies developed by governments from around the world. Many countries have attempted to perform the e-Government based on the functionality provided by Cloud Computing, some of these countries have achieved remarkable success, and others have confronted difficult to make it worked. Cloud-based e-government provides the best possible services to its citizens and businesses at purchasable cost. This is because governments don't need to purchase and install ICT equipment on their bases.

**Keywords:** cloud computing, e-government, cloud-based, challenges, cloud user.

### Introduction

The most visible expression of the growing government engagement with cloud technologies and companies are the high-level cloud strategies being developed and implemented by a number of nations around the world.[1] Today, Cloud Computing, this new technology, has effectively responded to thousands of their hardware and software needs, and it is considered the topic most requested by academics and research centres related to the field of information technology.[2] Cloud computing can be described as a new style of computing in which dynamically scalable and usually virtualized resources are stored as a service over the Internet. Cloud computing offers many features such as accessing, installing, downloading or downloading a wide variety of applications without the need for a user. It also reduces the costs of both running and installation of computers and software, as no infrastructure is required. Cloud computing offers companies increased storage than traditional storage systems.

### Cloud Computing

The traditional role of the service provider has been divided into two by Cloud computing-the infrastructure providers who manage cloud platforms and rent resources according to a usage-based pricing model and service providers who rent resources from one or many infrastructure providers to serve for the end users.[13]

Cloud computing divided into the deployment models and service delivery models.[5]

Cloud computing providers offer three fundamental service models: infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS)[3]

Infrastructure as a service (IaaS) - Cloud computing providers offer extra storage networking devices, physical and virtual computers etc. Cloud users abilities to install operating system images on the virtual machines as well as their application software. IaaS includes virtualized computers with secured processing power and reserved bandwidth for storage and Internet access. Include Amazon EC2, GoGrid and Flexiscale are IaaS providers

Platform as a service (PaaS) - is similar to IaaS, but also includes operating systems and required services for a certain application. Cloud user uses software or computing platforms such as web servers, databases operating systems and programming environments. Include Google App Engine, Microsoft Windows Azure, and Force.com are PaaS providers

Software as a service (SaaS)- allows users to use software and run applications remotely from the cloud. The main concern of cloud computing users is the security of the information stored or transmitted in the cloud. Examples of SaaS providers include Salesforce.com, Rackspace, and SAP Business By Design.

Depending on the differences in the deployment model, cloud services can be provided in four main ways: public cloud, private cloud, hybrid cloud and community cloud.

Public cloud - cloud relates to a cloud service transfer model in which a service provider makes massively scalable IT resources, such as CPU and storage capacities, or software applications, available to the general public over the Internet. Public cloud services are typically suggested on a usage-based model.

Private cloud - infrastructure is proprietary and is used exclusively by the owner organization. The largest and most comprehensive control is over the resources that form the cloud. In this model, the organization has full control over all configuration options of computing resources and existing service. The cloud is controlled by an organization and serves it wholly; it can exist inside or outside the organization's boundary.

Hybrid cloud - an organization can keep its crucial data and applications within their firewall while hosting the less crucial ones on a public cloud. The Hybrid Cloud is a mixture of both Private and Public.

Virtual Private Cloud (VCP)- is an alternative solution to addressing the limitations of both public and private clouds. A VPC is actually a platform running on top of public clouds.[8]

### e-GOVERNMENT

Governments throughout the world are supporting services in the best feasible way to perform daily activities, especially in government offices that have direct intercommunication with citizens. The use of the latest technologies is critical to decreasing the required time for the processing processes and improving interaction with citizens by providing efficient and effective services.

Realization of E-government projects is done aimed at gaining different goals and these goals are expected to observe the following principles:

- improve and increase providing governmental services
- empower citizens through access to information and the government's ability to interact and collaborate
- achieving greater transparency and accountability of government
- Improvement of the internal relationship between the government and the citizens' electronic delivery.

### Indentations and Equations

Cloud computing is penetrating in many areas because of its advantages. High scalability, low support efforts, enormous cost savings potential, and various benefits make cloud computing also impressive in e-Government. The decision on which cloud computing deployment model can be adopted for e-Government is difficult. Many countries have attempted to perform e-government to realize their goals with the principles mentioned above. Some of these countries have achieved remarkable successes in this area. Based on the Waseda University Institute ranking which is presented on March 25, 2013, Singapore is the foreground from the successful countries in the implementation of e-government. [4]

No	Final Ranking	Score
1	Singapore	94.00
2	Finland	93.18
3	USA	93.12
4	Korea	92.29
5	UK	88.76
6	Japan	88.30
7	Sweden	87.80
8	Denmark	83.52
9	Taiwan	83.52
10	Netherlands	82.54
11	Australia	82.10
12	Canada	81.78
13	Switzerland	81.33
14	Germany	80.08
15	Italy	79.11

Figure 1. The top 15 countries in implementation of e-government

It shows that governments present more advanced e-service performance, better access to information, more efficient management and improved interactions with peoples, primarily as a result of increasing use by the public sector of information and communications technology.

1-ci Beynəlxalq Elmi-Praktik Konfrans:

Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

Network Preparedness, Required Interface-functioning applications, Management Optimization, National portal, CIO in Government, e-Government Promotion, and e-Participation (Digital Inclusion) these main indicators used to rank the e-Government development of countries in the world.

Cloud computing comes with numerous opportunities and challenges simultaneously. Of the challenges, security is considered to be a crucial barrier for cloud computing in its path to success.[12]

The four risk vectors – many of which share commonalities with the risks we noted in the Government as a User section – can be briefly described as follows: outsourcing, internationalization, centralization, systemic complexity[6]

The main issues and challenges for cloud adoption in the public sector are security, data protection and compliance, data portability and interoperability, identity and access management, auditing. E-government automatically provides mixed management with cloud computing by solving resolution problems and helps to reduce the budget based on the actual use of the data.[9]

### Solution

The choosing of Cloud Computing in e-Government is not only a vision, it already becomes a reality. Many countries or cities, especially across Europe, have already chosen cloud computing solutions in the public sector or are planning to do so. One of the serious issues in cloud computing is to divide the workload uniformly between all nodes.

The main object-oriented principle involved with cloud computing is an abstraction and this is a process in which specific details are hidden, it helps to simplify the generalization process. For example, data can be stored in an unknown location in the cloud network. It really does not matter where it actually stored on a particular server. The server could be located in the next office or halfway around the world.

Cloud computing provides a variety of services that are suitable to run a business, especially in the ICT industry. Based on interviews, using more cloud services to run the company's operations, ranging from email correspondence, communicating with employees without having to be in the office, utilizing data analysis applications to survey company performance, to make product innovation new. Generally, the type of cloud used is a type of SaaS, which helps them manage their business operations effectively. While on data storage and server utilization using IaaS, some use more than one cloud computing service provider, to support one server activity when it is under repair or down. Most SMEs use public clouds, but some SMEs use private clouds because companies want security and privacy. However, this type of service must be paid at a relatively high cost.[11]

Cloud Computing is growing technology with lots of benefits. However, due to the complex architecture of the Cloud, many challenges arriving day by day. Some of the current challenges are: Load Balancing, Performance, Security, Interoperability/Communication between Clouds, Energy Consumption.

Load balancing plays an important role in enlightening the performance of the distributed system by shifting of workload among various nodes. Trust in the cloud is not a technical security issue, but it is the most effective soft factor that is driven by security issues inherent in cloud computing. So, it is difficult to use more than one cloud resources due to the incompatibilities between them. The combined use of cloud services is a challenge because of the lack of standardized APIs, each provider has its own techniques on how users and applications interact with the cloud infrastructure. Due to the high requirement of Cloud resources, data centres are deployed in large amount which needs a high amount of power. But for energy-efficient cloud, power loss must be reduced.

Unlike traditional solutions where warnings come from two known sources inside or outside the network; cloud computing security threats might originate from different sources.

### CONCLUSION

The world is rapidly migrating towards the cloud due to its cost-effective utilization of resources. Also, governments are also planning to develop cloud technology to increase the performance, quality, innovation and security in the services they provide to the citizens. In this paper, we presented a broad study on cloud computing, their characteristics, service model and deployment model. Additionally, discussed some challenges which need to be addressed to make cloud successful. The security aspect and the provision of limited internet connection infrastructure are still a challenge for the adoption of cloud computing. So far, the effective strategies and plans are still considered to be able to minimize the negative impacts of these challenges.

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# INCREASING SENSITIVITY OF HALL EFFECT POSITION SENSOR

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## ABSTRACT

In this study, deal with increasing accuracy of hall effect position sensor which play a key role in automotive sector. Hall effect position sensors are used on pedal for adjusting quantity of gas which flow through electronic throttle therefore sensor's accuracy and linearity impact main target fuel-efficiency and reduction low carbon-dioxide emission of spark ignition engine. Analog output of hall effect position sensor with noise due to temperature, vibration, mechanical, process and measurement effect were filtered by using infinite impulse response (IIR) filter. During study, we applied least square estimation based on linear model, autoregressive exogenous model (ARX) and Neural network model on filtered output of hall effect sensor. End of study, each parameter estimation method were compared with each other.

**Keywords:** hall effect, position sensor, increasing accuracy, parameter estimation methods, least square Estimation, autoregressive exogenous model, neural network model.

## INTRODUCTION

Hall effect sensor become even more important with development of semiconductor technology. Today, Hall effect sensors are one of the key part of automotive sector. Hall effect sensors are used as a contact-less sensor for linear position, angular position, velocity, rotation and electrical current[1]. In traditional automotive systems, the position of throttle is actuated by bowden cable. After development of throttle by wire systems (TBW), TBW system doesn't need any bowden cable between throttle valve and accelerator pedal. Nowadays, pedal position sensor is key element instead of bowden cable in a TBW system[2]. Sensor accuracy, sensitivity and linearity increasing methods are divided into software, software-hardware and hardware solution. The hardware solution brings extra cost in sensor designs[3].

In this paper, we applied parameter estimation methods which are based on least square estimation (LSM), neural estimation method (NNM) and autoregressive exogenous model (ARX) using Matlab software to increase sensitivity of hall effect position sensor. The organization of this work is as follows. In section 2, Our signal was introduced and the measured sensor output with noise is filtered by IIR filter, we described the basic principle of Least Square Estimation and autoregressive exogenous model in Section and this models were applied our system section 3. Section 4 introduce neural network system and applying of this method on our sensor data. In the end, section 5 concludes this paper.

## General Methodology

Measurement data were observed in simulation environment by data acquisition system. During measurement, we noticed that there is noise on analog sensor output. Zero mean white noise and process noise were added on analog signal output for creating robust mathematical model. The cut-off frequency were determined by using fast fourier transform. 3. degree IIR low pass digital filter were prepared for mathematical model which was used in algorithms. The voltage level between measured sensor angle and sensor output were normalized for decreasing error. The polynomial approximation within the sensor's linear operation was used to apply  $y=ax+b$  for the 3rd ARX order model's parameters, which were trained with LSE. It is applied by using the batch data obtained from the sensor to create the discrete time  $H(z)$  transfer function of the sensor. An artificial model was created by using artificial neural network as a nonlinear function approximator using batch data from the sensor. Sensor linear model, sensor linear model with noise, IIR filter output, sensor output FFT, sensor output FFT with noise and low pass filter FFT is showed in Figure 1.

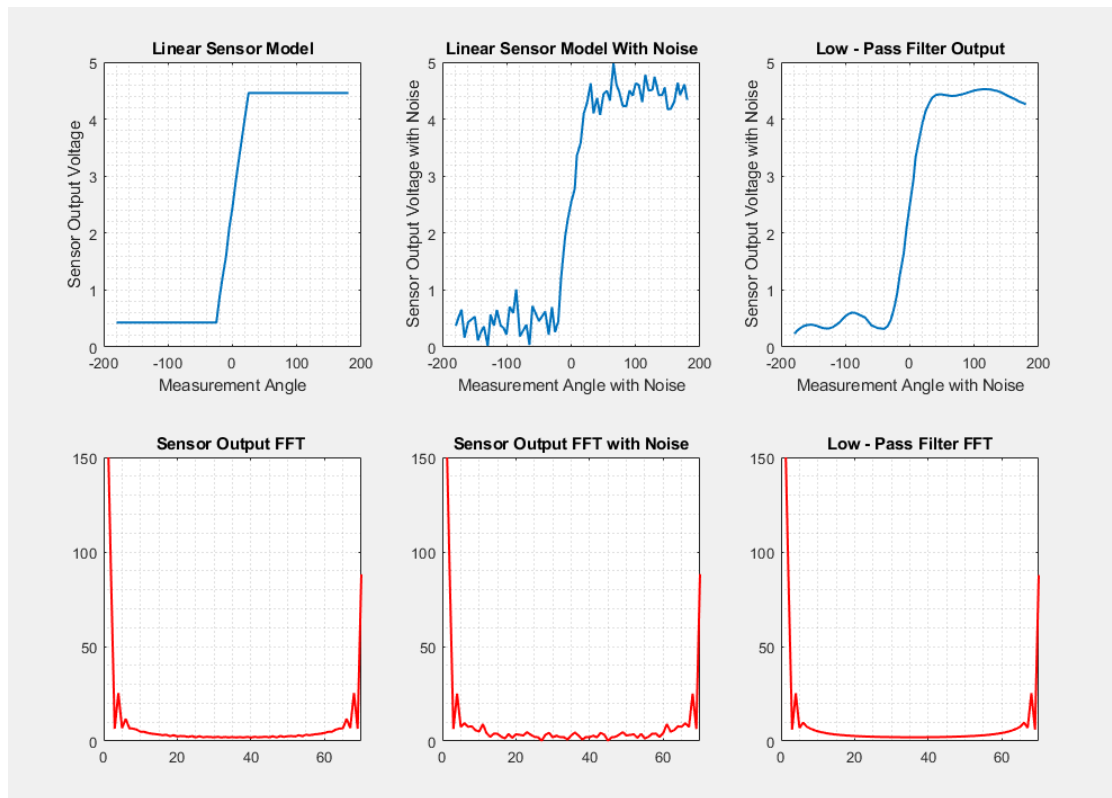


Figure 1.

### Applying of Least Estimation Linear Model on Sensor Data and Least Square Estimation Based Autoregressive Exogenous Model

Our data set, which is ready for algorithms, can be approximated with a linear line with the voltage level at the sensor's output in the range where the sensor's input angle change is  $\pm 30$  degrees. The unknown parameters (a,b) of  $y=ax+b$  line is found by using LSE for creating matrix A and vector y.

$$A = \begin{pmatrix} a_{11} & \dots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{m1} & \dots & a_{mn} \end{pmatrix} \quad (1)$$

m: The number of measurement data

n: The number of unknown parameter's coefficient of polynomial

A coefficient matrix is created for  $y=ax+b$  linear form 1.order polynomial.

$$A = \begin{pmatrix} a_{11} & b_{12} \\ \vdots & \vdots \\ a_{m1} & b_{m2} \end{pmatrix} \quad b = \begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} \quad (2)$$

Our problem is formed to  $Ax=b$  linear equation system. Unknown  $x$  vector is found

$$x = (A^T A)^{-1} A^T b \quad (3)$$

Normalized filtered sensor output is created. After this process,  $y=ax+b$  form linear model is applied by using sensor sparse data set as showed in Figure 2.

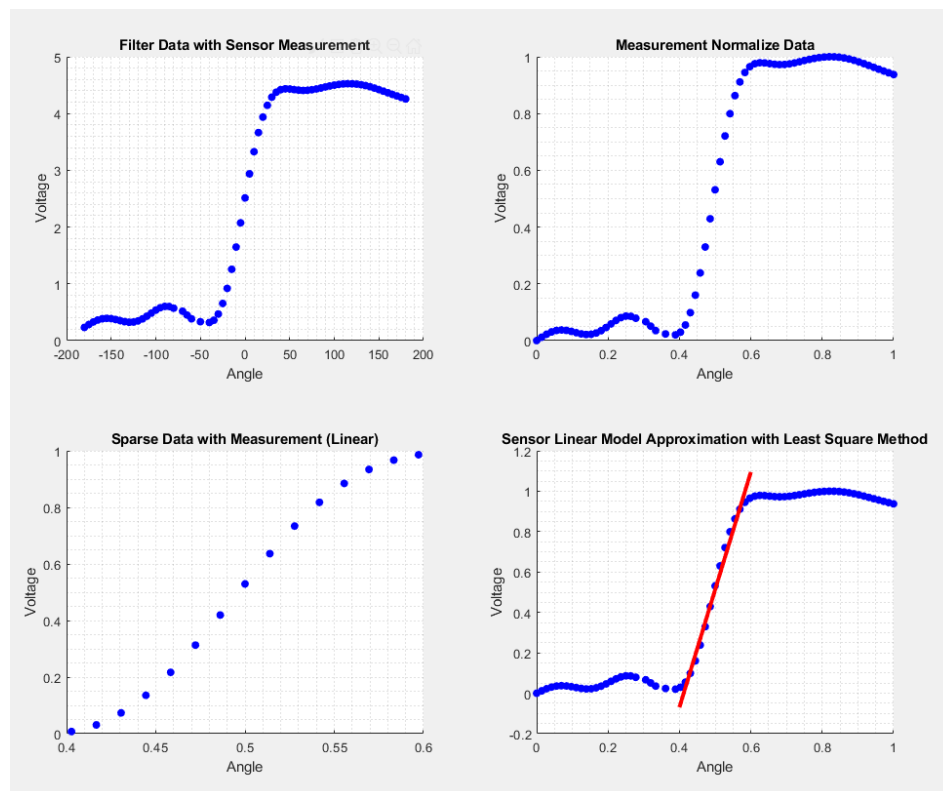


Figure 2.

The mathematical model is developed by assuming that the sensor remains linear in the working area;

$$y = (5.8188)x - (2.3970) \quad (4)$$

Firstly, we consider that ARX model structure, where the output  $y(k)$  at the current discrete time step is calculated based on previous input and output values;

$$A(q^{-1})y(k) = B(q^{-1})u(k) + e(k) \quad (5)$$

$$y(k) + a_1y(k-1) + a_2y(k-2) + \dots + a_nay(k-na) = b_1u(k-1) + b_2u(k-2) + \dots + b_nbu(k-nb) + e(k)$$

Above equation is equal to

$$y(k) + a_1y(k-1) + a_2y(k-2) + \dots + a_nay(k-na) = b_1u(k-1) + b_2u(k-2) + \dots + b_nbu(k-nb) + e(k) \quad (7)$$

$e(k)$  is the noise at step  $k$ .

Model parameters;  $a_1, a_2, \dots, a_{na}$  and  $b_1, b_2, \dots, b_{nb}$

Backward shift operator as follow in equation 8.

$$q^{-1}z(k) = z(k-1) \quad (8)$$

Where  $z(k)$  is any discrete-time signal

Then;

$$y(k) + a_1y(k-1) + a_2y(k-2) + \dots + a_nay(k-na) = (1 + a_1q^{-1} + a_2q^{-2} + \dots + a_naq^{-na})y(k) =: A(q^{-1})y(k) \quad (9)$$

And;

$$b_1u(k-1) + b_2u(k-2) + \dots + b_nbu(k-nb) = (b_1q^{-1} + b_2q^{-2} + \dots + b_nbq^{-nb})u(k) =: B(q^{-1})u(k) \quad (10)$$

Therefore, the ARX model is written compactly;

$$A(q^{-1})y(k) = B(q^{-1})u(k) + e(k) \quad (11)$$

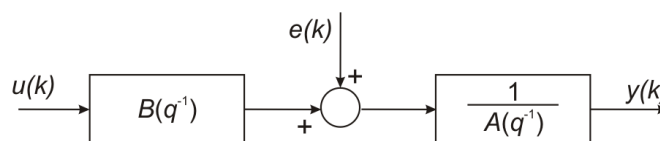


Figure 3.

The symbolic representation in the Figure 3 holds beacuse;

$$y(k) = \frac{1}{A(q^{-1})} [B(q^{-1})u(k) + e(k)] \quad (12)$$

The ARX model is quite general, it could describe arbitrary linear relationships between inputs and outputs. However, the noise enters the model in a restricted way and after that we introduce models generalize this.

Explicit recursive representation;

$$\begin{aligned}
 y(k) &= -a_1 y(k-1) - a_2 y(k-2) - \dots - a_{na} y(k-na) + b_1 u(k-1) + b_2 u(k-2) + \dots + b_{nb} u(k-nb) + e(k) \\
 &= [-y(k-1) \dots - y(k-na) u(k-1) \dots u(k-nb)] \\
 &= [a_1 \dots a_{na} b_1 \dots b_{nb}]^T + e(k) \\
 &= \varphi^T(k) \theta + e(k)
 \end{aligned} \tag{13}$$

ARX model avoid from the standard model structure in linear regression. We minimize the mean square error.

$$V(\theta) = \frac{1}{N} \sum_{k=1}^N \varepsilon(k)^2 \tag{14}$$

When  $k \leq na, nb$ , zero and negative-time values for  $u$  and  $y$  are needed to construct  $\varphi$ . They could be taken zero when assuming the system is in zero initial conditions.

From linear regression, minimized  $V(\theta) = \frac{1}{N} \sum_{k=1}^N \varepsilon(k)^2$  parameters are;

$$\theta = (\phi^T \phi)^{-1} \phi^T Y \tag{15}$$

The difference equation and transfer function obtained as a result of ARX model were found as follow equation 16.

$$0.9599y[n-2] - 2.872y[n-1] + 2.911y[n] = -0.00928x[n-2] - 0.0519x[n-1] + 0.06686x[n]$$

$$H(z) = \frac{0.06686z^2 - 0.05519z - 0.009218}{2.911z^2 - 2.872z + 0.9599} \tag{16}$$

After the ARX model is created, the pulse response of  $H(z)$  transfer function created for sensor is seen in figure 3. The ARX model is determined as  $rms=0.0016$ . The ARX model output and the sensor output are shown on the right in figure 4.



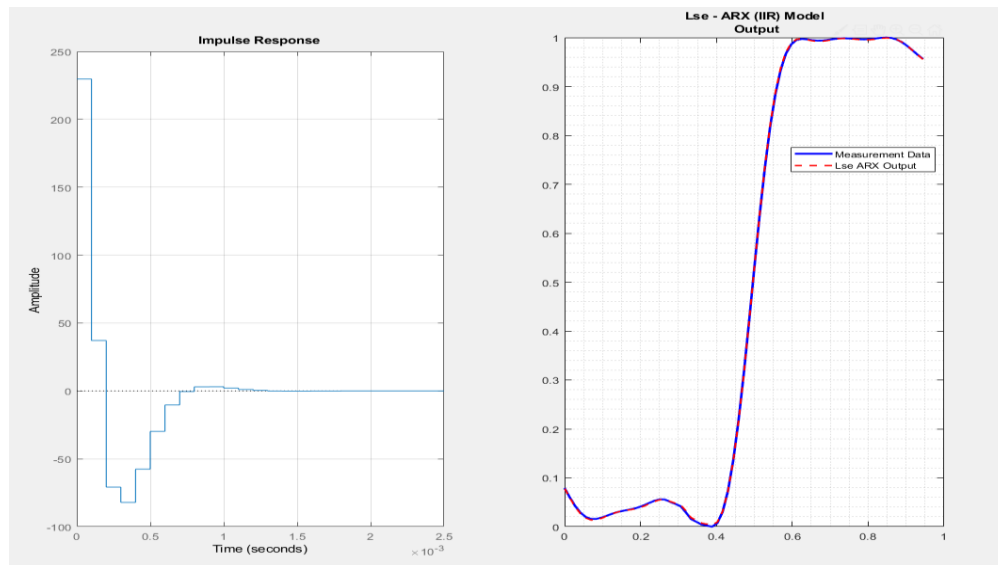


Figure 4.

#### Multi Input Single Output Artificial Neural Network Based Nonlinear System Identification with Sensor Measurement Data

The development of mathematical models for nonlinear sensors were remained weak for signals with linear models. The artificial model developed by an universal function approximation model, such as artificial neural networks, allow us to make modelling even when our measurement is not linear[4]. In this work, multi input single output with hidden layer and 11 neurons are used. Artificial neural networks were modeled using the back propagation algorithm and the optimization algorithm Levenberg Marquat. The completion of the neural network is trained after 10000 iteration, the performance of model is increased. The artificial neural network made a much stronger approximation than the ARX model, resulting in a decrease in rmse error value. In this study, an artificial neural network(ANN) with 11 neurons and a single-layer hidden layer with multiple inputs has been modeled as in Figure 5. To find the model parameters of ANN, the back propagation algorithm have been used. Artificial neural networks work as nonlinear function approximators, i.e. nonlinear regression.

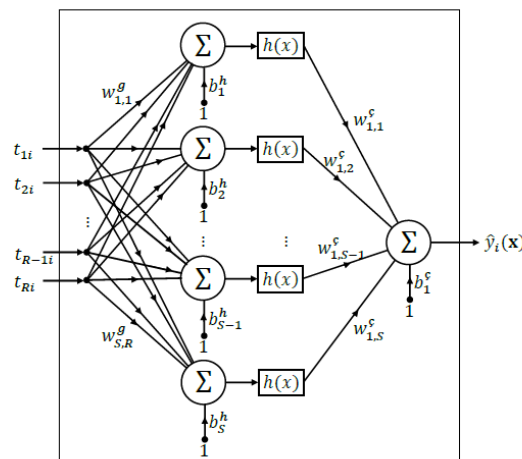


Figure 5. The input-output relationship of artificial neural network is as follows.

$$\hat{y}_i(x) = W^c h(W^s t_i + b^h) + b_1^c \quad (17)$$

$W^c$  : Output Weight

$W^s$  : Input Weight

$b^h$  : Hidden Layer Bayes

$b_1^c$  : Output Layer Bayes

$h(.)$  : Activation Function

Model parameters of artificial neural networks are randomly initialized and the parameters are updated with the levenberg marquart method after each epoch. Result of this method is showed in figure in figure 6.

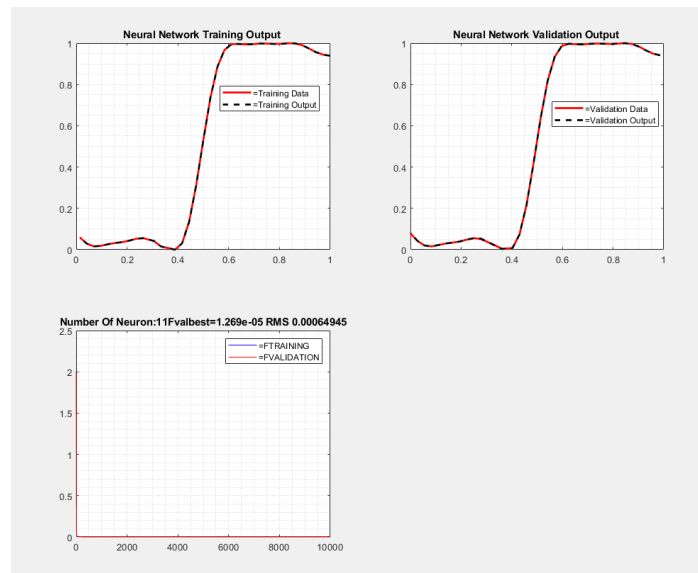


Figure 6.

## CONCLUSION

Sensor model is accepted as a black box model, while creating mathematical modelling of sensors. Sensor input and output data were collected with this method. Data collection and preprocessing is very important for modelling. In this paper, ARX and ANN models could be applied on embedded system platform. Sensor measurement and process noise should be filtered by digital filter before applying method on embedded system.  $H(z)$  transfer function cause easy use for future close-loop control system. Sensor's mathematical model increase control performance.

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## BER AND Q-FACTOR PERFORMANCES OF A 60 GHZ MILLIMETER WAVE GENERATION USING NARROW-BAND BRAGG FILTERS

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### ABSTRACT

In this paper, we study a new technique for millimeter wave generation using a RoF system based on the use of narrow band Bragg filters as reflectors of very specific wavelengths. The proposed system performance depends on various parameters, mainly: optical fiber length, FBG bandwidth, optical power.etc. In our case, the different simulations have been carried out in order to show the effect of the optical fiber length on the eye diagram, the quality factor and the BER values. The obtained results indicate that the proposed system remains efficient for fiber lengths up to 70 Km with a bit rate of 1 Gbit/s and a FBG bandwidth of  $10^{-6} \text{ nm}$ .

**Keywords:** Millimeter Waves, FBG, Radio-over-Fiber (RoF), Quality factor (Q), Bit Error Rate (BER).

### INTRODUCTION

Currently, there is a huge need for communication services with very high bandwidths and higher service speed. Therefore, in front of this growing need, low-frequency communication bands are no longer in effect.

Wireless technologies generally operate in the frequency ranges around 2.4 GHz or 5 GHz, however these ranges are widely used around the world, making them highly saturated. The millimeter frequency band around 60 GHz has proven to be an effective solution thanks to its unlicensed band and worldwide availability, and has some other advantages, including a large bandwidth and high data rates of up to several Gigabits per second, allowing users to enjoy a very high connection speed. In addition, millimeter waves are quite attractive due to the possibility of reusing frequencies resulting from their attenuation as a function of distance, as well as the low interference due to other existing radio systems [Error! Reference source not found.] [Error! Reference source not found.].

On the other hand, millimeter waves suffer very high losses during their propagation in free space, in the order of 15 dB/Km, which considerably limits their transmission distance. For this reason, Radio-Over-Fiber technology has taken place as a powerful technology to avoid constraints and transmit the millimeter waves with very low losses through the use of the optical fiber characterized by a very high bandwidth, low losses and high transmission security [Error! Reference source not found.] [Error! Reference source not found.].

The generation of millimeter waves is carried out by many methods, mainly: Millimeter-wave generation by Direct and External Intensity Modulation [Error! Reference source not found.], millimeter-wave generation by two lasers [Error! Reference source not found.], and Millimeter-wave generation using a single intensity modulator [Error! Reference source not found.]. In this paper, the generation of millimeter waves is achieved by the RoF technology based on the use of Bragg grating filters reflecting very specific frequencies [Error! Reference source not found.] [Error! Reference source not found.] [Error! Reference source not found.] [Error! Reference source not found.].

The schematic diagram of the proposed system is described in section 2. The simulations carried out are presented in section 3. Then, a conclusion is included in section 4. System description

The schematic diagram representing the optical link simulated in this paper is shown in Fig.1. The wavelength spectrum emitted by a laser diode at a power of 20 dBm and a frequency of 193.1 THz, is injected into the input of the first FBG, which is a narrow-band filter allowing the reflection of a specific wavelength noted  $\lambda_1$  ( $\lambda_1 = 1553.8 \text{ nm}$ ). Then, the spectrum transmitted by the first FBG will be subsequently injected into the input of the second FBG, which in turn will reflect a second wavelength  $\lambda_2$  ( $\lambda_2 = 1553.3 \text{ nm}$ ).

A coupler is used to combine the two reflected wavelengths ( $\lambda_1$  and  $\lambda_2$ ) whose output is connected to an optical fiber that transmits them to a PIN photodiode placed at the system output. Finally, the optical signal corresponding to the two reflected wavelengths is visualized at the photodiode; where the difference between the two wavelengths is equal to 60 GHz. Therefore, a generation of 60 GHz millimeter waves is performed using the proposed system simulated with Optisystem software.

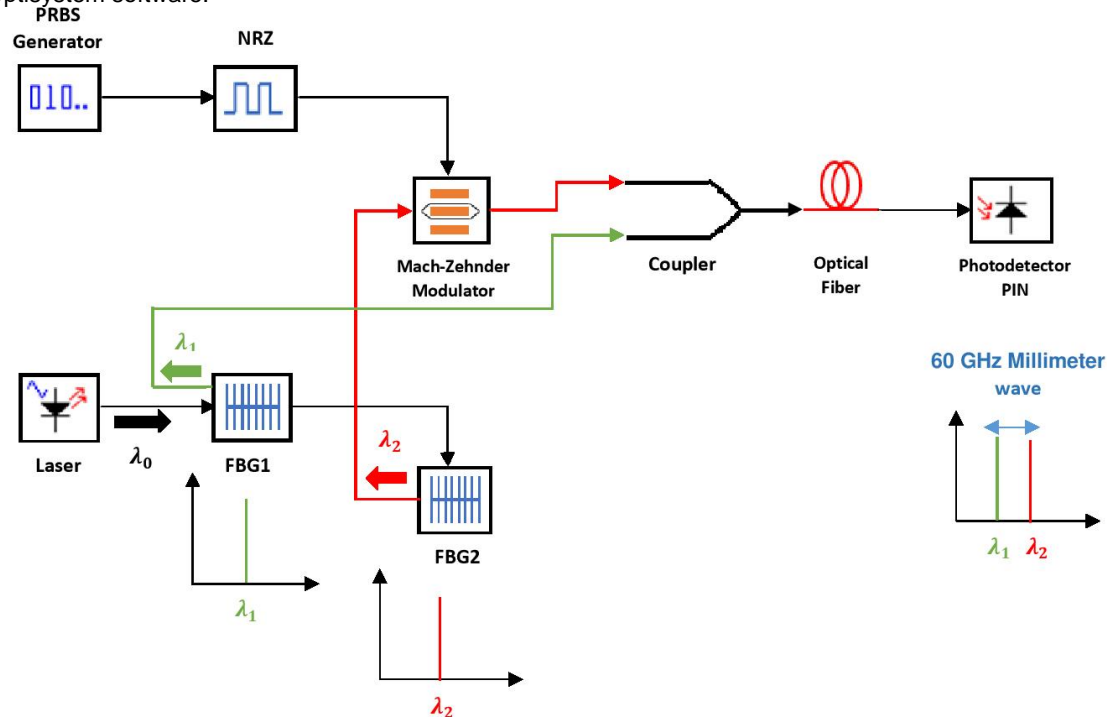


Fig.1. Schematic diagram of the simulated system for millimeter wave generation

### Simulation results

In this section, we present the results of the simulation performed using the proposed system described in the previous section, where the values of the used parameters are presented in the Table.1. The performance of the 60 GHz millimeter wave generation system is evaluated by studying the effect of the variation of optical fiber length on the eye diagram, the quality factor (Q) and the Bit Error Rate (BER).

Parameters		Values
PRBS Generator	Bit rate	1 Gbit/s
	Frequency	193.1 THz
	Power	20 dBm
Diode laser	Bandwidth	500 MHz
	Extinction ratio	30 dB

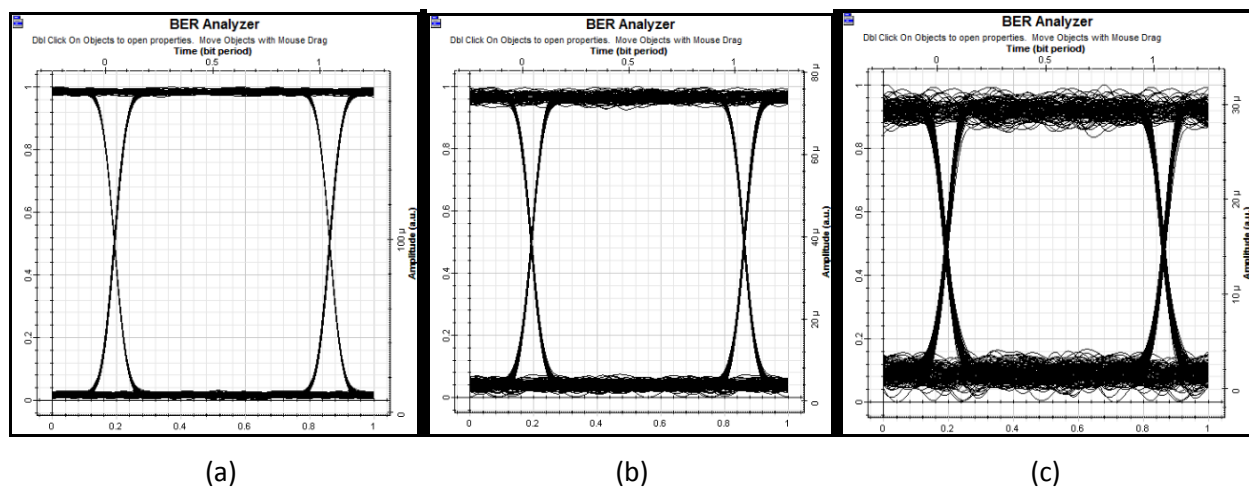


<b>1<sup>st</sup> Bragg Filter</b>	Frequency	193.07 THz
	Bandwidth	$10^{-6}$ GHz
	Reflectivity	0.99
<b>2<sup>nd</sup> Bragg Filter</b>	Frequency	193.13 THz
	Bandwidth	$10^{-6}$ GHz
	Reflectivity	0.99
<b>Optical Fiber</b>	Loss	0.2 dB/Km
	Dispersion	16 ps/nm/Km
<b>Photodetector</b>	Responsivity	1 A/W
	Dark current	10 nA

Table.1. Parameters' values used in the simulation

**Effect of optical fiber length on the eye diagram**

In this section, we evaluate the proposed system performance by varying the optical fiber length while visualizing the eye diagram for each length. The bit rate is set at 1 Gbit/s, the power at 20 dBm and the FBG bandwidth at 0.6 nm. As shown in Fig.2, it is clear that the opening of the eye diagram for short lengths of optical fiber is better than that for long lengths. As the length increases, the eye closes more and more. The opening of the eye diagram remains good for optical fiber lengths up to 70 km. From this length, the clarity of the eye deteriorates and the transmission quality no longer remains good.



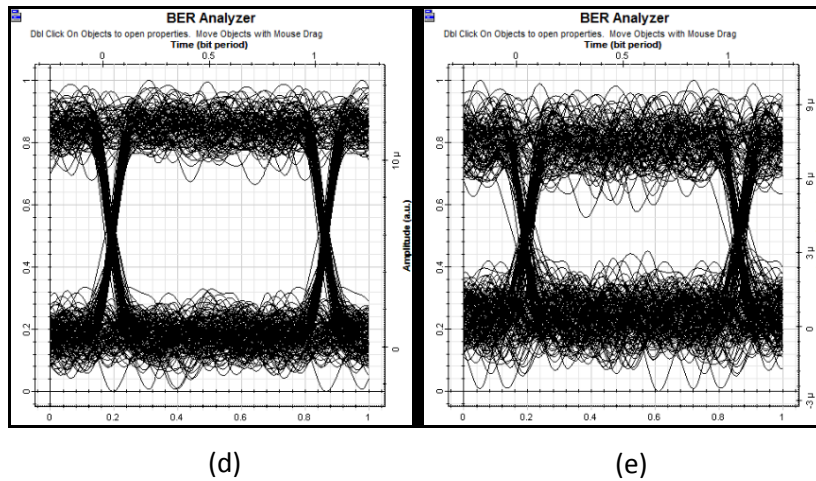


Fig.2. Eye diagram for (a) L= 10 Km, (b) L= 30 Km, (c) L= 50 Km, (d) L=70 Km and (e) L=80 Km with D= 1Gbit/s and P= 20 dBm.

Variation of the quality factor Q and the bit error rate BER as a function of the optical fiber length

In this section, we are interested in the effect of fiber length on the quality factor Q and the bit error rate BER. As shown in Fig.3, the quality factor reaches its maximum at a distance of 10 km, and then as the length increases, the signal quality deteriorates. In addition, above 80 km, the quality factor Q reaches almost null values.

Similarly, Fig.4 shows the variation of the BER as a function of fiber length. It is clear that the BER is almost zero for all lengths less than 70 km. From this length, the BER is no longer acceptable because its value exceeds the tolerated value, which is in the order of  $10^{-5}$ . For example, the BER corresponding to 70 Km is  $8.0734 \times 10^{-14}$ , while for a distance of 80 km, the BER is about  $1.23 \times 10^{-6}$ .

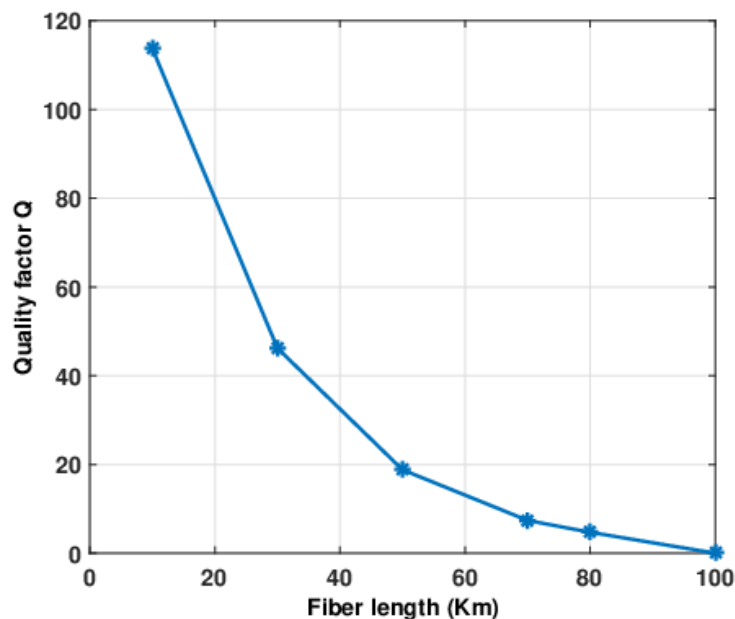


Fig.3. Variation of the quality factor Q as a function of the optical fiber length

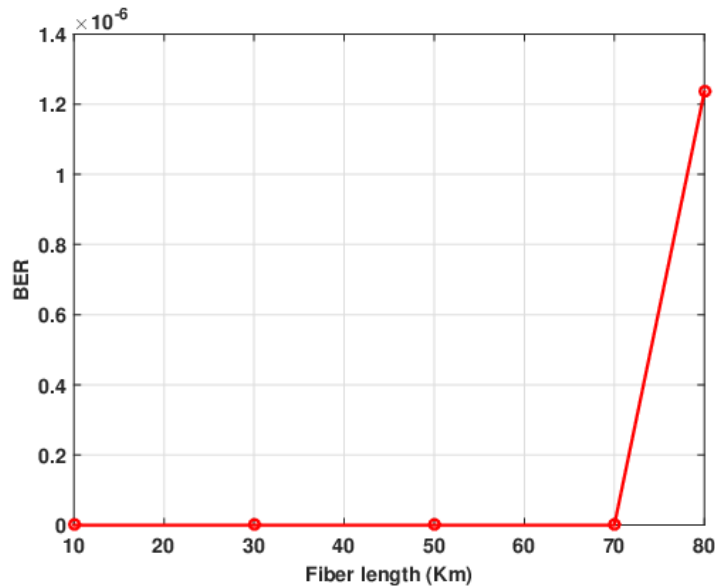


Fig.4. Variation of the bit error rate BER as a function of the optical fiber length

## CONCLUSION

A new technique for millimeter wave generation using a RoF system based on narrow band Bragg filters has been proved in this paper. The simulations performed show that the transmission quality of the proposed system is influenced by varying the optical fiber length. The obtained results display that the eye diagram remains clear for fiber lengths up to 70 km and that the Quality factor (Q) and the Bit Error Rate (BER) also take an acceptable value. The proposed system in this paper can also be effective for long transmission distances by connecting, for example, several fibers with a length of 70 km.

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## MATHEMATICAL MODELING OF GASLIFT PROCESSES CONTROL SYSTEMS

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### ABSTRACT

It is offered improved adequate mathematical models taking into account change of structure and phase for description and optimal control of multiphase time-dependent processes which happen in oil wells exploited by gaslift method, expressed by means of a system of differential equations and taking into account using of their stochastic analogues. Conception of system approach demands to develop means providing optimal exploitation of gaslift complex, or to improve most progressive means from existing ones. To approach to the problem from a wider scientific conception, taking into account a stochastic character of the happened processes more complicates mathematical models and hydromechanical equations that we already got into habit are brought to a solution of nonlinear stochastic differential equations.

**Keywords:** oil well, intermittent gaslift, stochastic process, working substance, optimal process.

It is created improved adequate mathematical models taking into account change of structure and phase for description and optimal control of multiphase time-dependent processes which happen in oil wells exploited by gaslift method, expressed by means of a system of differential equations and taking into account using of their stochastic analogues. It has been got a solution by analytical method of a motion process under influence of different phase speeds of the two-phase mixed liquid (Landau-Raxmatulin model) and the nonlinear changing temperature field. It has been shown applied ways of the solution to learning of gaslift processes. A mathematical model and control algorithm of the problem of distribution of the working substance among gaslift wells have been developed. Criteria for optimal distribution of the working substance among wells under its limited condition have been analysed and selected. A software for solution of the problem of optimal distribution of the working substance on the basis of created model has been created. Taking into account a stochastic character of the forces influencing to the system during the vertical motion of gas-liquid mixture through the oil-well tubing an optimal control system of gaslift complex has been created. A more perfect and adequate mathematical deterministic and stochastic model of motion of gas-liquid mixture through the vertical oil-well tubing inside the well is offered. Changing ways of calculation algorithms within of possibilities of the SCADA control system used for optimizing of gaslift complex in mines at present have been investigated. A more perfect and adequate mathematical deterministic and stochastic model of motion of gas-liquid mixture through the vertical oil-well tubing inside the well:

The equation of uninterrupted of the flow in the pipe;

$$\frac{\partial \rho_m}{\partial t} + \frac{\partial(\rho_m u_m)}{\partial x} = 0.$$

the equation of changing of the motion quantity;

$$\frac{\partial(\rho_m u_m)}{\partial t} + \frac{\partial(\rho_m u_m^2)}{\partial x} = -\frac{\partial P_r}{\partial x} - \rho_m g - f \frac{\rho_m u_m^2}{2D_i}$$

for incompressible fictitious fluid (mixture):

$$\frac{\partial u_m}{\partial x} = 0.$$



From these equations we find the system of equations characterizing a time-dependent motion of the mixture in the vertical pipe:

$$\frac{\partial \rho_m}{\partial t} + u_m \frac{\partial \rho_m}{\partial x} = 0; \quad (1)$$

$$\rho_m \frac{\partial u_m}{\partial t} = -\frac{\partial P_T}{\partial x} - \rho_m g - f \frac{\rho_m u_m^2}{2D_i}. \quad (2)$$

Where  $g$  is an acceleration of gravity,  $u_m$  – a vertical speed of the fluid;  $P_T$  – a pressure in the pipe;

$f$  – a coefficient of hydraulic resistance;  $D_i$  – an entrance diameter of oil-well tubing. Boundary condition:

The 1st boundary conditional is for a vertical pipe. It is a condition of flowing of the liquid from the productive layer to the vertical pipe. Using Dupui formula for the vertical well we shall be able to write the boundary conditions

in the well bottom zone as following:

$$Q_i[x=0] = \frac{J(P_g - P_{wf})}{\rho_l}; \quad (3)$$

$$J = \frac{2\pi kh}{\mu \log[r_s/r_w]}; \quad Q = uA. \quad (4)$$

Quantity of the gas injected into the well  $Q_g[x=0] = q_i$ . Because of this equals to the quantity of the measurable on the wellhead, extracted gas

$$Q_m[x=L] = kA_c \sqrt{\frac{2(P_{wh} - P_{sep})}{\rho_m}}.$$

$$\frac{\partial^2 p}{\partial r^2} + \frac{1}{r} \frac{\partial p}{\partial r} = \frac{c\sigma\mu}{k} \frac{\partial p}{\partial t}.$$

$$u_l = -\frac{2\pi kh}{\mu} r \frac{\partial p}{\partial r}; \quad Q_l = u_l A;$$

$$A = 2\pi r_w^2 h. \quad Q_l[x=0] = \frac{J(P_g - P_{wf})}{\rho_l};$$

We will use equations of secondly flow of the mixture to get the motion equation for the excited state of the fluid during the gaslift:

$$\frac{\partial \rho_m}{\partial t} + \left(\frac{Q_m}{A_T}\right) \frac{\partial \rho_m}{\partial x} = 0;$$

$$\frac{\rho_m}{A_T} \frac{\partial Q_m}{\partial t} = -\frac{\partial P_T}{\partial x} - \rho_m g - f \frac{\rho_m Q_m^2}{2D_i A_T^2}.$$

The main problem is to specify stable conditions of the mixture motion in the oil-well tubing. Therefore let us characterize changing of the state parameters of the system as following.

$$\rho_m = \rho_{m,0} + \delta\rho; \quad Q_m = Q_{m,0} + \delta Q; \quad P_T = P_{T,0} + \delta P$$

If we accept the moving fluid as an incompressible environment:

$$\frac{\partial(\rho_{m,0})}{\partial x} = 0; \quad \frac{\partial(Q_{m,0})}{\partial x} = 0; \quad \frac{\partial(P_{T,0})}{\partial x} + \rho_{m,0}g + f \frac{\rho_{m,0}Q_{m,0}^2}{2D_i A_T^2} = 0.$$

In result for the state of the excited motion of the gas-liquid mixture we get:

$$\frac{\partial(\delta\rho)}{\partial t} + \left(\frac{Q_{m,0}}{A_T}\right) \frac{\partial(\delta\rho)}{\partial x} = 0; \quad (5)$$

$$\frac{\rho_{m,0}}{A_T} = \frac{\partial(\delta Q)}{\partial t} = -\frac{\partial(\delta\rho)}{\partial x} - \delta\rho g - f \frac{1}{2D_1 A_T^3} (Q_{m,0}^2 \delta\rho + 2\rho_{m,0} Q_{m,0} \delta Q). \quad (6)$$

We get the following expression for a general flow of the mixture. It shows being of this general flow equal to the total of flows of the gas and liquid parts.

$$Q_m = Q_{s,l} + Q_{s,g}, \quad (7)$$

The same we can say for exciting.

$$\delta Q_m = \delta Q_{s,l} + \delta Q_{s,g},$$

$$\delta Q = \delta Q[x=0].$$

Boundary conditions for excitings are as following:

$$\delta Q_m[x=0] = \delta Q_{s,l}[x=0] + \delta Q_{s,g}[x=0].$$

as volume of the gas injected into the oil-well tubing is constant then the condition in the well bottom zone

$$\delta Q_{s,g}[x=0] = \delta(q_{injection}) = 0.$$

The same we can say for oil flows:

$$\delta Q_m[x=0] = \delta Q_{s,l}[x=0] = 0;$$

As a result we get for the general flow in the wellhead

$$(Q_m[x=L]) = \delta Q_{s,l}[t] = v(t).$$

Integrating the motion equation along the pipe in the interval of (0,L) we get the differensial equation of the excited flow through the whole oil-well tubing as following

$$\begin{aligned} \frac{\rho_{m,0}}{A_T} L \frac{\partial(\delta Q)}{\partial t} = & -(\delta[x=L]) - \delta P[x=0]) - g \left( \left( \int \delta\rho[x=L] \left(\frac{Q_{m,0}}{A_T}\right) dt \right) - \left( \int \delta\rho[x=0] \left(\frac{Q_{m,0}}{A_T}\right) dt \right) \right) - f \frac{1}{2D_1 A_T^3} \left( \left( \int \delta\rho[x=0] \left(\frac{Q_{m,0}}{A_T}\right) dt \right) - \right. \\ & \left. \left( \int \delta\rho[x=L] \left(\frac{Q_{m,0}}{A_T}\right) dt \right) \right) Q_{m,0}^2 + 2\rho_{m,0} Q_{m,0} (\delta Q L). \end{aligned}$$

Become excitings of the density of the flow environment have been included to this equation. In the previous known investigations this quantity was taken as average or in general as a constant. Therefore in the next investigations the expression of the density was shown as an implicit function of the time. The general symbolical solution of this equation is in the following form  $\delta\rho(x,t) \rightarrow \phi\left(\frac{tQ_{m,0}-xA_T}{Q_{m,0}}\right)$ . Where  $\phi\left(\frac{tQ_{m,0}-xA_T}{Q_{m,0}}\right)$  is any differentiable function and has a wave character. After some mathematical conversions we get:

$$\phi\left(t - \frac{xA_T}{Q_{m,0}}\right) = \delta\rho = \left( \left( \partial_{Q_g} \rho_m \right) \delta Q_g + \left( \partial_{Q_l} \rho_m \right) \delta Q_l / \{ \delta Q_l \rightarrow v(t), \delta Q_g \rightarrow 0 \} \right) = \frac{Q_g(p_l - p_g)}{(Q_g + Q_l)^2} v(t)$$

In the well bottom zone  $x=0$

$$\phi\left(\frac{v(t)}{Q_{m,0}}\right) = \frac{Q_g v(t)(p_1 - p_g)}{(Q_g + Q_1)^2} = \frac{q_1(p_1 - p_g)}{(q_1 + Q_{m,0})^2} v(t);$$

In the wellhead  $x=L$

$$\phi\left(\frac{v(t) - L A_T}{Q_{m,0}}\right) = \frac{q_1(p_1 - p_g) v\left(\frac{v(t) - L A_T}{Q_{m,0}}\right)}{(q_1 + Q_{m,0})^2}.$$

Integrating the motion equation on the  $x$  coordinate along the well we find:

$$\begin{aligned} \frac{\rho_{m,0}}{A_T} L \frac{\partial(v(t))}{\partial t} = & -(\delta P[x=L] - \delta P[x=0]) - g \left( \left( \int \left( \frac{q_1(p_1 - p_g) v\left(\frac{v(t) - L A_T}{Q_{m,0}}\right)}{(q_1 + Q_{m,0})^2} \right) \frac{Q_{m,0}}{A} dt \right) - \right. \\ & - \left( \int \left( \frac{q_1(p_1 - p_g)}{(q_1 + Q_{m,0})^2} v(t) \right) \frac{Q_{m,0}}{A} dt \right) \right) - f \frac{1}{2 D_1 A_T^2} \left( \left( \int \left( \frac{q_1(p_1 - p_g) v\left(\frac{v(t) - L A_T}{Q_{m,0}}\right)}{(q_1 + Q_{m,0})^2} \right) \frac{Q_{m,0}}{A} dt \right) - \right. \\ & \left. \left. - \left( \int \left( \frac{q_1(p_1 - p_g)}{(q_1 + Q_{m,0})^2} v(t) \right) \frac{Q_{m,0}}{A} dt \right) \right) - Q_{m,0}^2 + 2 L p_{m,0} Q_{m,0} v(t) \right) \end{aligned} \quad (8)$$

Differentiating expression (8) on time we get the following differential equation to find changing of density of the flow in the well.

$$\begin{aligned} \frac{\rho_{m,0}}{A_T} L \frac{\partial^2(v(t))}{\partial t^2} = & - \left( \frac{\partial(\delta P[x=L] - \delta P[x=0])}{\partial t} \right) - g \left( \left( \frac{q_1(p_1 - p_g) v\left(\frac{v(t) - L A_T}{Q_{m,0}}\right)}{(q_1 + Q_{m,0})^2} \right) \left( \frac{Q_{m,0}}{A} \right) - \right. \\ & \left( \frac{q_1(p_1 - p_g)}{(q_1 + Q_{m,0})^2} v(t) \right) \left( \frac{Q_{m,0}}{A} \right) \right) - f \frac{1}{2 D_1 A_T^2} \left( \left( \frac{q_1(p_1 - p_g) v\left(\frac{v(t) - L A_T}{Q_{m,0}}\right)}{(q_1 + Q_{m,0})^2} \right) \left( \frac{Q_{m,0}}{A} \right) - \right. \\ & \left. \left. - \left( \frac{q_1(p_1 - p_g)}{(q_1 + Q_{m,0})^2} v(t) \right) \left( \frac{Q_{m,0}}{A} \right) \right) - Q_{m,0}^2 + 2 L p_{m,0} Q_{m,0} \right). \end{aligned} \quad (9)$$

At last, after some known mathematical conversions we get

$$P[x=0] = p_{w,f} = p_R \frac{Q_1[x=0] \rho_l}{J};$$

$$\delta p_{w,f} = \delta P[x=0] = - \frac{\delta Q_1[x=0] \rho_l}{J};$$

$$\frac{\partial(\delta P[0])}{\partial t} = - \frac{\rho_l}{J} \frac{\partial \delta Q_1[x=0]}{\partial t} = - \frac{\rho_l}{J} \frac{\partial(v(t))}{\partial t}$$

$$p_{w,h} = \frac{\rho_m Q_m[x=L]^2}{(k A_c)^2} = \frac{\rho_m (Q_{m,0} + \delta Q[x=L])^2}{(k A_c)^2} + p_{sep} =;$$

$$\delta p_{w,h} = \delta P[L] = \delta \left( \frac{\rho_m Q_m[x=L]^2}{(k A_c)^2} + p_{sep} \right)$$

$$\frac{\delta \rho_m Q_m[x=L]^2}{(k A_c)^2} + \frac{\rho_m \delta(Q_m[x=L]^2)}{(k A_c)^2} =$$

1-ci Beynəlxalq Elmi-Praktik Konfrans:

Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

$$\frac{Q_g v \left( \frac{r Q_{m,0} - L A_T}{Q_{m,0}} \right) (p_i - p_g)}{(Q_g + Q_i)^2} \frac{Q_m [x=L]^2}{(k A_c)^2} + \frac{2 \rho_m Q_m [x=L] \delta(Q_m [x=L])}{(k A_c)^2};$$

$$\delta Q_m = \delta Q_{s,l} + \delta Q_{s,g}; \quad \delta(Q_m [x=L]) = \delta Q_{s,l} + \delta Q_{s,g} [t] = v(t);$$

$$\frac{\partial(\delta P[L])}{\partial t} = \frac{Q_g (p_i - p_g)}{(Q_g + Q_i)^2} \frac{Q_m [x=L]^2}{(k A_c)^2} \frac{\partial \left( v \left( \frac{r Q_{m,0} - L A_T}{Q_{m,0}} \right) \right)}{\partial t} +$$

$$\frac{2 \rho_m Q_m [x=L]^2}{(k A_c)^2} \frac{\partial \left( v \left( \frac{r Q_{m,0} - L A_T}{Q_{m,0}} \right) \right)}{\partial t} = [Q_m [x=L] = Q_{m,0}]; \quad (33)$$

$$[Q_i = Q_{m,0}] = \frac{q_i (p_i - p_g)}{(q_i + Q_{m,0})^2} \frac{Q_{m,0}^2}{(k A_c)^2} \frac{\partial \left( v \left( \frac{r Q_{m,0} - L A_T}{Q_{m,0}} \right) \right)}{\partial t} + \frac{2 \rho_{m,0} Q_{m,0}}{(k A_c)^2} \frac{\partial \left( v \left( \frac{r Q_{m,0} - L A_T}{Q_{m,0}} \right) \right)}{\partial t}.$$

This equation is a differential equation of the excited motion of two-phase liquid in the top part of the well (in the well head). Differentiating equation (8) on time and taking into account expression (9) we find result equations of the motion in the wellhead:

$$\frac{\rho_{m,0}}{A_T} L \frac{\partial^2(v(t))}{\partial t^2} = \left( \frac{q_i (p_i - p_g)}{(q_i + Q_{m,0})^2} \frac{Q_{m,0}^2}{(k A_c)^2} \frac{\partial \left( v \left( t - \frac{L A_T}{Q_{m,0}} \right) \right)}{\partial t} + \right.$$

$$\left. + \frac{2 \rho_{m,0} Q_{m,0}}{(k A_c)^2} \frac{\partial \left( v \left( t - \frac{L A_T}{Q_{m,0}} \right) \right)}{\partial t} + \frac{\rho_l}{j} \frac{\partial(v(t))}{\partial t} \right) - g \left( \left( \frac{q_i (p_i - p_g) v \left( t - \frac{L A_T}{Q_{m,0}} \right)}{(q_i + Q_{m,0})^2} \right) \left( \frac{Q_{m,0}}{A_T} \right) - \right.$$

$$\left. - \left( \frac{q_i (p_i - p_g)}{(q_i + Q_{m,0})^2} v(t) \right) \left( \frac{Q_{m,0}}{A_T} \right) \right) - f \frac{1}{2 D_i A_T^2} \left( \left( \frac{q_i (p_i - p_g) v \left( t - \frac{L A_T}{Q_{m,0}} \right)}{(q_i + Q_{m,0})^2} \right) \left( \frac{Q_{m,0}}{A_T} \right) - \right.$$

$$\left. - \left( \frac{q_n (p_i - p_g)}{(q_j + Q_{m,0})^2} v(t) \right) \left( \frac{Q_{m,0}}{A_T} \right) \right) Q_{m,0}^2 + 2 L \rho_{m,0} Q_{m,0} \frac{\partial(v(t))}{\partial t}.$$

Stationary flows and the amount of extracted liquid (oil) at that time are more important from the practical side during exploitation time. That is why let us write the differential motion equation for the stationary state

$$-\frac{\partial(P_{T,0})}{\partial x} - \rho_{m,0} g - f \frac{\rho_{m,0} Q_{m,0}^2}{2 D_i A_T^2} = 0$$

Integrating of this equation along the well axis is brought to the solution of algebraic equations for finding the average unknown quantity during the stationary flow of the liquid phase in the well.

$$P_{T,0}[x=L = P_{T,0}[x=0] - \rho_{m,0} g L] - f L \frac{\rho_{m,0} Q_{m,0}^2}{2 D_i A_T^2}$$

We use the following known expressions for finding the average volume of extracted liquid and the injected gas:

$$Q_{m,0} = Q_{s,l} + q_i$$

Where  $Q_{s,l}$  is a consumption of the liquif phase. If we express other variables in the equation with  $Q_{m,0}$  then we get the following for the average density of the stationary flow extracted from the well

$$\rho_{m,0} = \frac{p_g q_{injection} + p_l Q_{s,l}}{q_{injection} + Q_{s,l}} = \frac{(p_g - p_l) q_{injection} + p_l Q_{m,0}}{Q_{m,0}}$$

For the average pressure in the exploitation wellhead

$$P_{T,0}[x = L] = \frac{\rho_{m,0} Q_{m,0}^2}{2(kA_c)^2} + p_{sep} = \left( \frac{(p_g - p_l) q_i + p_l Q_{m,0}}{Q_{m,0}} \right) \frac{Q_{m,0}^2}{2(kA_c)^2} + p_{sep} = \left( (p_g - p_l) q_i + p_l Q_{m,0} \right) \frac{Q_{m,0}}{2(kA_c)^2} + p_{sep}$$

Where  $p_{sep}$  is the pressure intended beforehand for processing of the system in the separator. At the same time we get the following expression for the average pressure in the well bottom

$$P_{T,0}[x = 0] = p_R - \frac{p_l Q_{s,l}}{PL} = p_R - \frac{p_l (Q_{m,0} - q_i)}{J} \quad \text{Here the catchment pressure of the liquid in the external boundary of reservoir is signed with } p_R. \text{ From this we get the following algebraic equation to specify } Q_{m,0}:$$

$$\left( (p_l - p_g) q_i + p_l Q_{m,0} \right) \frac{Q_{m,0}}{2(kA_c)^2} + p_{sep} = p_R - \frac{p_l (Q_{m,0} - q_i)}{J} - \rho_{m,0} gL - fL \frac{1}{2D_i A_T^5} \left( \left( (p_l - p_g) q_i + p_l Q_{m,0} \right) \frac{Q_{m,0}}{2(kA_c)^2} + p_{sep} \right) Q_{m,0}^2 \quad (41)$$

Solution of this equation allows to calculate the average flow rate of the oil well during exploitation by gaslift method in the stationary state and control and finally optimize the well productivity by means of controllable characteristic parameters. Integrating of this equation along the well axis is brought to the solution of algebraic equations for finding the average unknown quantity during the stationary flow of the liquid phase in the well.

$$P_{T,0}[x = L = P_{T,0}[x = 0] - \rho_{m,0} gL] = -fL \frac{\rho_{m,0} Q_{m,0}^2}{2D_i A_T^5}$$

We use the following known expressions for finding the average volume of extracted liquid and the injected gas:

$$Q_{m,0} = Q_{s,l} + q_i \quad Q_{s,l} = Q_{m,0} - q_i$$

Where  $Q_{s,l}$  is a consumption of the liquif phase. If we express other variables in equation (9) with  $Q_{m,0}$  then we get the following for the average density of the stationary flow extracted from the well:

$$\rho_{m,0} = \frac{p_g q_i + p_l Q_{s,l}}{q_i + Q_{s,l}} = \frac{(p_g - p_l) q_i + p_l Q_{m,0}}{Q_{m,0}}$$

These models were created on the basis of simplifications according to correlations based on statistics, were adapted to the activities and politics of the concrete company. Different results for the same object of the different collections is explained with this. Regular or periodic gaslift method is used in more than 60% of the world oil production regions. That is why scientific researches in this area were intensified. Different valuable results have been received got in 15-20 recent years. A process of usage and development of the qazlift method in our country and the world have been fully learnt in this paper. Theoretical and practical requirements necessary for optimizing of these researches, more influential parameters important to be taken into account, usage more progressive and perfect technology and equipment in the measurement and production, possibilities of using existing and purchasable program packages are analysed. Algorithms and software which will be used in the practice have been created.

For the average pressure in the exploitation wellhead

$$P_{T,0}[x = L] = \frac{\rho_{m,0} Q_{m,0}^2}{2(kA_c)^2} + p_{sep} = \left( \frac{(p_g - p_i)q_i + p_i Q_{m,0}}{Q_{m,0}} \right) \frac{Q_{m,0}^2}{2(kA_c)^2} + p_{sep} =$$

$$= \left( (p_g - p_i)q_i + p_i Q_{m,0} \right) \frac{Q_{m,0}}{2(kA_c)^2} + p_{sep}$$

Where  $p_{sep}$  is the pressure intended beforehand for processing of the system in the separator. At the same time we get the following expression for the average pressure in the well bottom:

$$P_{T,0}[x = 0] = p_R - \frac{p_i Q_{i,l}}{p_L} = p_R - \frac{p_i(Q_{m,0} - q_{i,section})}{J} \quad (9)$$

In (9) the catchment pressure of the liquid in the external boundary of reservoir is signed with  $p_R$ . Taking into account (8) and (9) in (5) we get an algebraic equation to specify  $Q_{m,0}$ .

$$\left( (p_i - p_g)q_i + p_i Q_{m,0} \right) \frac{Q_{m,0}}{2(kA_c)^2} + p_{sep} = p_R - \frac{p_i(Q_{m,0} - q_i)}{J} - \rho_{m,0} g L -$$

$$- f L \frac{1}{2D_1 A_1^3} \left( \left( (p_i - p_g)q_i + p_i Q_{m,0} \right) \frac{Q_{m,0}}{2(kA_c)^2} + p_{sep} \right) Q_{m,0}^2$$

For the purpose of creating more adequate mathematical model of the considering problem it has been got a solution for the produced mixture for the time-dependent state on the basis of mutual penetrating environments (Landau- Raxmatulin) model by means of taking into account temperature changings along the well. The solution was used in the calculation algorithm. Analysis of the numerous (hundreds of) scientific and technical literature considered by authors has shown that offered algorithms are more complex and perfect. In the former Soviet Union they used calculation models created on the basis of MQUA algorithm. Now in our country OLQA program package is mostly used. Although these program packages are much used universal sets they have been formed as solution sets of linear problems. Expressions got in the represented paper allow to specify and control suitable exploitation conditions of gaslift oils by means of determining the amount of the liquid volume gathered in gaslift oils and the gathering time.

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## ACCESSIBILITY AND EFFICIENCY OF USING LEARNING MANAGEMENT SYSTEMS IN THE HIGH EDUCATION (Moodle, Canvas, Its learning)

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### Abstract

The article is devoted to the effective impact of the Learning Management System (LMS) in the high education. LMS allows choosing rational learning tools, combining traditional and innovative approaches to student and teacher personal development, organized independent work of students in the high level, providing an opportunity for the educational process to be individual, to create video collections, presentation. LMS is a specific application for documentation, administration, reporting. It's important to use LMS in the education, because it will help to improve the process of interaction between the student and the teacher. Today there are many suppliers of LMS. However, we turn to the most used ones (Moodle, Canvas, Its learning).

**Key words:** Learning Management System (LMS), high education, Moodle, Canvas, Its learning.

### Introduction

The globalization in the modern world is primarily due to the growth of knowledge. Therefore, digital technologies require improvement, rethinking according to the challenges of our time. In an era of modernization important to use digital technology in all aspects of life (we use them at home and work, when ordering tickets and paying bills, etc.). In our days the process of using digital technology in all areas is very relevant. World's information trends emphasize the fact that e-education is popular, and this requires teachers and students to be seriously prepared and responsive to the teachings of a modern informative society. Digital technology allows us to be independent, develop critical thinking, save time, successfully combine various means, methods of teaching and perform tasks, regardless of time, place and opportunity.

In the high educational used **Learning Management System (LMS)** or **Digital Learning Platforms (DLP)**. This system is used to plan, conducted and evaluate learning processes. LMS is an integral part of the educational process. This, in our opinion, ensures the effectiveness of training, makes it more interesting and modern. It is important to use certain systems that could have online courses, classroom course schedules and descriptions, tracking, and instructor and facilities scheduling [14].

LMS and their effectiveness was researched in many countries ([1], [2], [3], [4], [7], [9] [10], [12], [15], [18]). Numerous scientific researches show that the using LMS is a topical in the modern life, «past decade has seen enormous growth in the use of learning management systems (LMS) in higher education institutions, with varying levels of support provided to staff and students during the implementation phases».

For this reason Gåsland (2011) convinces: LMS is an important success factor for these systems, they are easy to use. The teacher is considered learnings platforms as the one who «holds the knowledge», transmits it to students, foster their learning [8].

Another researcher Dobre (2015) accentuates that «the future belongs to LMSs, considering that the modern higher education demands the fulfillment of some critical requirements in order to be successful».

LMS, according to Lopes (2014), give possibilities to systematize basic tasks. Moreover, stresses the author, assessments can be straightaway delivered to the student, and upon conclusion, immediately returned with grades and detailed feedback. Therefore LMS can also be used for assessment purposes in Higher Education [15].

### Moodle, Canvas, Its learning

Important to say, that many universities have already an LMS [13]. According to statistics (the largest number of users – 142,106, 528), the biggest digital learning platform is **Moodle** [16]. Moreover, the most popular features of Moodle are: True Open Source, Powerful, flexible and collaborative learning, Easy communications, Accurate grading, Easy course editing, Data-driven decisions, Full integration, Latest multimedia tools, Extendable & customizable, Safe and secure [16]. These features make it easy to use LMS Moodle.

1-ci Beynəlxalq Elmi-Praktik Konfrans:

Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

(Screenshot 1, Retrieved from <https://moodle.com/features/>)



Pedagogical platform *Moodle* is used for high education in many countries (Argentina, Australia, Brazil, Canada, Spain, United Kingdom, France, Italy etc.). In Ukraine also many institutions use the learning platform *Moodle*. According to the Ukrainian scientist Shcherbyna (2015), Moodle platform are free to use to evaluate any competencies. The researcher is turning also to the benefits of using LMS Moodle [19]. The necessary condition for its application, notes the scientist, is the development and constant updating of the nomenclature of industries, competencies and points of the repository. The nomenclature of industries and competences should be developed at the level of national standards of higher education and be in line with international standards. Educational institutions can be involved in the development of points for assessing competencies. It allows taking into account local peculiarities of the organization of the educational process [19].

Another Ukrainian scientist – Myshchyshe (2011) – points out the disadvantages of using the platform Moodle [17]:

- ✓ not adapted to create complex educational work;
- ✓ poorly integrated with external programs;
- ✓ does not contain bibliographic education and planning of training in the specialty;
- ✓ has somewhat limited communication capabilities;
- ✓ the absence of such technical support from the manufacturer.

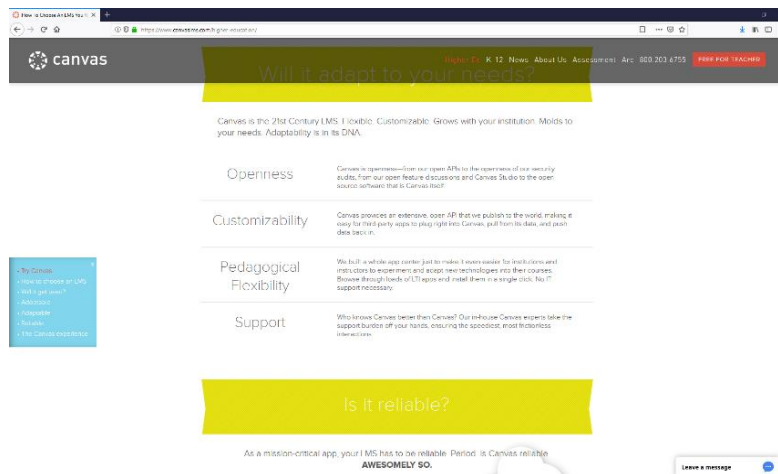
The author also points out that there is an urgent need to change the strategy of distance learning, in particular in improving the qualification in the process of using information technology based on the learning platform Moodle. Therefore, the formation and development of the professional competence of teachers and students using the information system Moodle helps to integrate and improve the content, tools, methods and forms of learning [17].

LMS «**Canvas**» and «**its learning**» wide use in the Norwegian high education. «Canvas» was founded in 2008. Canvas used by more than 3000 universities, school districts, and institutions around the world. This suggests that «Canvas» is designed for students to become more efficient in the methods of communication, discussion, collaboration, and assessment through online learning, «pushing» global society forward [20].

Digital learning platform «Canvas» has the following *advantages* [11]:

- ✓ **Openness** (openness of our security audits).
- ✓ **Customizability** (free publish, easy for using).
- ✓ **Pedagogical flexibility** (to making it easier for institutions and instructors to experiment and adapt new technologies into their courses).
- ✓ **Support**.

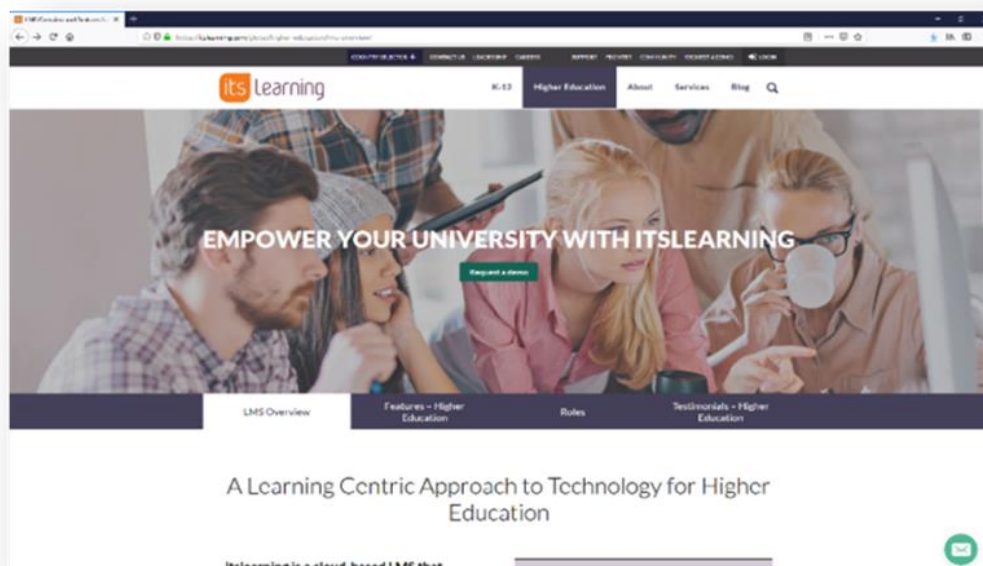
(Screenshot 2, Retrieved from <https://www.canvaslms.com>)

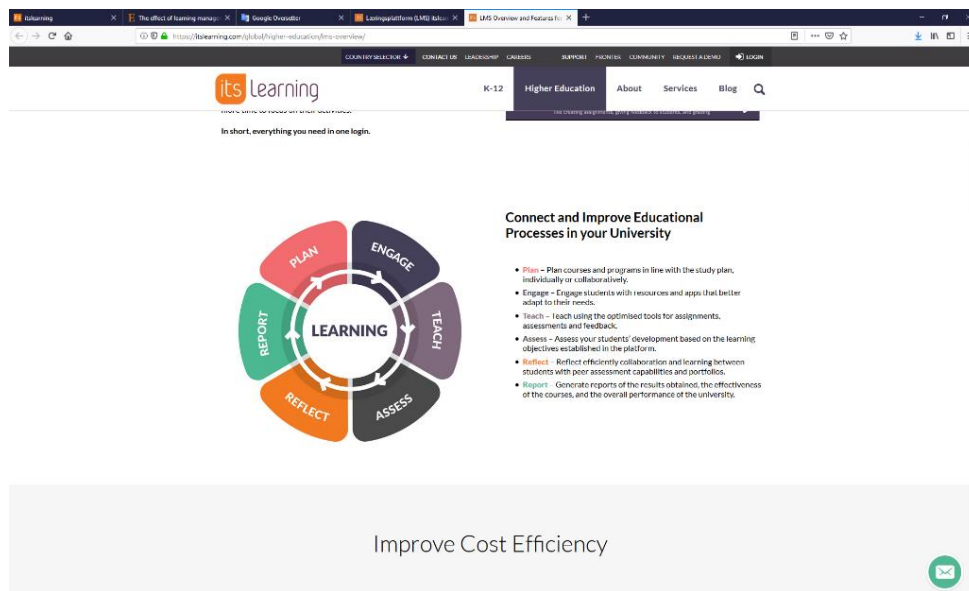


LMS «Its learning» helps teachers and students in six key points [6]:

- ✓ **Planning** of the educational process
- ✓ **Engaging** students with resources and apps. They are built according to the needs of students.
- ✓ **Teaching** and using the optimized tools for assessments and feedback.
- ✓ **Assessing** students based on the learning objectives.
- ✓ **Reflecting** efficiently collaboration between students and teachers (with peer assessment).
- ✓ **Formation** of reports on the results obtained (effectiveness of the educational process and overall productivity of the institution).

(Screenshot 3, Retrieved from <https://itslearning.com>)



(Screenshot 4, Retrieved from <https://itslearning.com>)

### Conclusions

As can be seen, digital technology in our time plays very important role. In education especially effective to use LMS (gain knowledge and save time, create new projects, communicate with others). We emphasize that LMS demonstrates advantages due to in formativeness, accessibility, especially economic efficiency. It also requires less time and energy to absorb knowledge, more mobility and comfortable.

The benefits of using LMS can be graphically depicted as follows (see Table 1):

Table 1

Advantages of using LMS		
Ability to study at a convenient time	Ability to study in any place	Accessibility of training materials
Independence in solving set tasks	Comfortable learning conditions	Constant communication between the teacher and the student
Mobility (accessibility and efficiency)	Using of various methods and means of training	Possibility of active organization of each student

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## INDICATIONS FOR PRENATAL KARYOTYPING

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### ABSTRACT

The article provides an analysis of the results of prenatal diagnosis (174 cases) performed at the Center for Genetic Diagnostics "AFGEN" for 2015-2017. Chromosomal abnormalities were detected in 5.1% of cases. The most frequent anomaly in our own material was trisomy XXI (Down's disease), in the second place were balanced translocations. Based on the results, the need for wider use of prenatal diagnosis in the region was indicated. Only in this way can chromosomal abnormalities in the fetus be detected in a timely manner and the birth of children with gross malformations can be prevented.

**Keywords:** chromosomal abnormalities, cordocentesis, amniocentesis, chorionic villus aspiration, placenta biopsy.

### РЕЗЮМЕ

Статья обеспечивает анализ результатов пренатальной диагностики (174 случая) выполненный в Центре генетической диагностики "AFGEN" за 2015-2017. Хромосомные аномалии были обнаружены в 5,1% случаев. Наиболее частой аномалией на собственном материале была трисомия XXI (Болезнь Дауна), на втором месте оказались сбалансированные транслокации. На основе результатов было указано необходимость более широкого применения пренатальной диагностики в регионе. Только таким образом можно своевременно выявить хромосомные аномалии у плода и предупредить рождение детей с грубыми пороками развития.

**Ключевые слова:** хромосомные аномалии, кордоцентез, амниоцентез, аспирация ворсин хориона, биопсия плаценты

### REZÜME

Məqalədə 2015-2017-ci illər ərzində "AFGEN" genetik diaqnoz mərkəzində aparılan prenatal diaqnostikanın (174 halda) nəticələrinin təhlili verilmişdir. 5,1% halda xromosom anomaliyaları aşkar olunmuşdur. Ən çox rast gəlinən anomaliya trisomiya XXI (Daun xəstəliyi), II yerdə balanslaşmış translokasiyalar olmuşdur. Nəticələrə əsaslanaraq müəllif prenatal diaqnostikanın tətbiqinin genişləndirilməsinin vacibliyini göstərmişdir. Qeyd etmişdir ki, ancaq bu yolla döldə xromosom anomaliyalarını vaxtında aşkar etmək və inkişaf qüsuru olan uşaqların doğulmasının qarşısını almaq mümkündür.

**Açar sözlər:** xromosom anomaliyaları, kordosintez, amniosintez, xorion xovlarının aspirasiyası, plasentanın biopsiyası

Prenatal diagnosis has become a major aid to genetic counseling and for this, several important areas of technology have evolved, especially cytogenetic prenatal diagnosis, using analysis of cultured cells from the amniotic fluid at mid-trimester. Because of its high reliability and safety record with the lowest fetal loss and embryonic damage, amniocentesis has become the most common practice for prenatal diagnosis. However, CVS (chorionic villus sample) has gained popularity as a successful first trimester prenatal diagnostic technique since the mid 1980s, probably because of the advantage of establishing a diagnosis some weeks earlier in the pregnancy. During the last decades the study of fetal karyotypes has become a very important tool for genetic counseling on recurrence risk and/or fetal chromosome diagnosis of at-risk pregnancies (Magalhaes, 2001). Invasive prenatal diagnosis continues to be the standard method for searching for chromosomal aneuploidies or other genetic diseases (Bui, 2007). Prenatal diagnosis of cytogenetic abnormalities is now widely recognized as a reliable method with an acceptable risk for couples at high risk of giving birth to a child with clinically significant chromosome abnormalities (Caron *et al.*, 1999). Despite the fact that in Brazil amniocentesis and CVS were first introduced by Nazareth *et al.* (1981) and Gollop *et al.* (1988) respectively, there is still no public health care policy for application of cytogenetic prenatal diagnosis. As in other developing countries, this test is mostly confined to expensive private clinics, which means that it is rarely available for the great majority of pregnant women who depend on public medical services. Nevertheless, we have been offering this test in our Center for Genetic Diagnostics "AFGEN" since 2015. Prenatal diagnosis is a very restricted test in Baku, mainly because induced abortion, even indicated by fetal genetic disease, is not legally allowed.

Even with the development of modern techniques, cell culture failure remains one of the main obstacles to be overcome. In order to improve the chance of getting a karyotype result, alternative fetal samples, such as urine or cystic hygroma



fluid were used for chromosome analysis when malformations were found in the fetus and availability of conventional tissues was limited. The purposes of this study were: 1) to describe the most frequent indications for karyotyping the fetus in our socio-economic conditions; 2) to estimate the frequency of the most common prenatal chromosome abnormalities in patients 3) to assess the cytogenetic results obtained with alternative tissue samples compared to amniocytes and chorionic villi.

Cytogenetic findings were retrospectively reviewed from 2005 to 2007 in 174 pregnant women, with a mean maternal age of 32.7 years, and mean gestational age of 22.7 weeks. Those women underwent prenatal cytogenetic evaluation only after a genetic counseling session, which means that risks, methods and indications were explained to the family. All samples were collected by a various gynecologists. The method used for sample collection was transabdominal puncture guided by ultrasound. Samples were obtained for all patients, even in cases of lack of amniotic fluid, when alternative fluids were collected. Amniotic fluid, or any other fetal sample collected, were cultivated in long-term cell cultures, with Amniomax medium, at 37 °C in CO2 incubator. Cordocentesis followed the standard blood culture that means, short-term culture (72 h) at 37 °C, and no requirement for a CO2 incubator. We used standard Giemsa-banding staining technique for all chromosome analyses. Cordocentesis is a procedure used to obtain a sample from fetal blood directly from the umbilical cord in cases where amniocentesis is not possible or is used to give a quick result only in high-risk cases since procedure related pregnancy loss is high. The paper provides analysis of results of invasive prenatal diagnostics (174 cases) performed at various surgical clinics in Baku and Center for Genetic Diagnostics "AFGEN" over 2015-2017.

Chromosomal anomalies were detected at 5,1% of cases. The most frequent pathologies were Down's syndrome and balanced translocations. Indications for prenatal diagnosis were formed on the basis of standard risk factors.

The main one was the age of pregnant women over 35 years old and serum markers of chromosomal abnormalities. Based on the findings, the author pointed out the necessity of wider application of invasive prenatal diagnostics in the region.

Table 1

Indications for prenatal karyotyping

Indications	Year			Total	
	2015	2016	2017	Number	%
Age of pregnant women over 35 years old	17	27	19	63	36,2
Biochemical markers	5	12	19	36	20,6
Gross developmental malformations	9	11	10	30	17,2
Markers of chromosomal abnormalities	3	12	4	19	10,9
Ultrasound markers	4	3	4	11	6,3
Child with Down's Disease in the family	3	5	1	9	5,1
Parents – carriers of chromosomal anomalies	1	2	3	6	3,4

Prenatal diagnosis has become a major aid to genetic counseling and for this, several important areas of technology have evolved, especially cytogenetic prenatal diagnosis, using analysis of cultured cells from the amniotic fluid at mid-trimester. Because of its high reliability and safety record with the lowest fetal loss and embryonic damage, amniocentesis has become the most common practice for prenatal diagnosis (Park et al., 2001). However, CVS (chorionic villus sample) has gained popularity as a successful first trimester prenatal diagnostic technique since the mid 1980s (Brambati et al., 1998), probably because of the advantage of establishing a diagnosis some weeks earlier in the pregnancy. Cordocentesis is a procedure used to obtain a sample from fetal blood directly from the umbilical cord in cases where amniocentesis is not possible or is used to give a quick result only in high-risk cases since procedure related pregnancy loss is high (Costa et al., 1998).

The results of fetal cytogenetic abnormalities in our study are similar to those reported in the literature (Caron et al., 1999). Several studies have shown that Down syndrome is the most common and clinically significant cytogenetic abnormalities detected in prenatal cytogenetic studies, followed by balanced translocations (Song et al., 1997; Han et al., 2000). This was also found to be the case in our own series. The frequency of chromosomal abnormalities in the general population is estimated to be 0.5% of live births, but the frequency within the high-risk population is higher (around 5%, as observed in newborns with malformation by Nazer et al., 2003, in Chile). Our Medical Genetic Service, as a reference center, receives patients who have been screened already by physicians in other Centers (without Genetic Services available)

1-ci Beynəlxalq Elmi-Praktik Konfrans:

Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)

Karyotyping unconventional fetal samples, when it is difficult to obtain the traditional ones, is not a very common approach in most laboratories. We used this alternative when necessary and achieved a 100% success rate on an admittedly limited sample of 13 cases; however, the success rate is higher than that observed in other studies

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## BINARY-, AND TERNARY- CHALCOGENIDES PERSPECTIVE LASER MATERIALS IN MODERN INFORMATION AND CONTROL SYSTEMS

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### ABSTRACT

Binary layered  $A^mB^n$  (where **A**- is for Ga, In and **B**- is for S, Se, Te) and ternary rare-earth doped ( $Eu^{2+}$ ,  $Nd^{3+}$ ,  $Ce^{3+}$ ) thiogallate structure  $A^mB^nC_4^p$  (where **A**- is for Ca, Sr, Ba; **B**- is for Ga, Al and **C**- is for S, Se, Te) semiconductor compounds reveal outstanding nonlinear optical (NLO) (GaSe- gallium selenide) and effective photoluminescence (PL) ( $CaGa_2S_4$ - calcium-gallium thiogallate) properties.

**The purpose of our research** is to study optical and NLO properties of GaSe and  $Eu^{2+}$ -doped  $CaGa_2S_4$  and  $CaGa_2Se_4$ , including laser oscillations in latter two crystals.

Polycrystalline GaSe were obtained by melting metallic Ga and powdered Se in an evacuated (up to  $10^{-5}$ Torr) quartz ampoules. Single crystals of GaSe were grown by the Bridgman method by using the same ampoules with previously synthesized materials. Polycrystalline ternary rare-earth doped crystals were grown in an evacuated quartz tubes from binary  $CaS$  ( $CaSe$ ) and  $Ga_2S_3$  ( $Ga_2Se_3$ ) compounds and  $EuF_3$  (dopant). Single crystals were grown by chemical vapor transport reaction method using iodine ( $I_2$ ) as a transporter.

**Crystal structure and quality** of grown crystals were determined by X-ray analysis. Existing data and some researches performed at the National Aviation Academy (NAA) and at the Institute of Physics, confirmed that grown GaSe crystal reveals highly effective NLO properties allowing tunable generation in a wide spectrum of electromagnetic radiation (from near IR to THz range of spectra).

Laser oscillations observed for ternary compounds in the present work confirm perspectives of using these materials as an active media in lasers.

**Research performed** shows perspectives and possibility of using these crystals for application in modern information, measurement and control systems.

The authors are thankful to the guide of SOCAR for financial support.

**Keywords:** layered crystals, ternary thiogallate, nonlinear optics, laser spectroscopy, laser oscillations.

## INTRODUCTION

GaSe is known as outstanding NLO crystal having practical applications in laser tuning from near IR up to THz range of electromagnetic spectrum [1-5]. More than 2000 existing articles devoted to growth, thermodynamic, structure, optical and NLO properties indicate that GaSe is outstanding crystal for applications in mid-to far-IR and THz range at the same time for the modulation of different laser lines.

**Four modifications have been** described for GaSe [6]: •centrosymmetric  $\beta$ - type consists of 2 layers per unit cell and has the space group (SG)  $D_{6h}^4$ . Its existence in pure GaSe was the subject of discussions; •noncentrosymmetric  $\varepsilon$ - modification is the main component obtained from the melt, SG  $D_{3h}^1$ , contains 2 layers; •the simplest modification is  $\gamma$ , SG  $C_{3v}^5$ , which contains only 1 layer and, hence, is also noncentrosymmetric. Latter often exist as stacking faults in  $\varepsilon$ - type; •the  $\delta$ - type grows from the vapor phase and contains 4 layers, is noncentrosymmetric, SG  $C_{6v}^4$ .

$CdGa_2S_4$  ( $Se_4$ ) crystals are characterized by the presence of stoichiometric vacancies typical of the defective  $Ga_2S_3$  ( $Ga_2Se_3$ ) binary compounds. These semiconductors crystallize in a tetragonal structure ( $a = b \neq c$ ), called thiogallate or defect chalcopyrite, which belongs to  $S_4^2$  (class 4) SG [7]. The distinctive features of these crystals as a promising material for NLO are a wide transparency range of  $0.4 \div 13 \mu m$  and the NLO coefficient  $d_{36} = 64 \times 10^{-9}$  ESU, which was measured to be about 5 times larger than  $d_{31}(LiNbO_3)$ . Besides, these crystals revealed effective photo luminescence (PL) properties [8].

All the above-mentioned peculiarities make it interesting to grow, characterize and investigate poly-, and bulk- crystals of GaSe and ternary chalcogenide with thiogallate structure- for practical applications in modern information and control systems.

The main aim of present research - was to grow single crystals of GaSe and ternary thiogallate  $CdGa_2S_4$  ( $Se_4$ ) crystals, to investigate their optical and NLO properties and give some recommendations for practical applications of these materials in information and control systems.

## Experimental technique

Polycrystals of GaSe were obtained by melting metallic Ga and powdered Se in an evacuated (up to  $10^{-5}$  Torr) ampoules. Single crystals were grown by the Bridgman method by using the same ampoules with synthesized materials and were characterized by different techniques including: •X-ray diffraction; •UV-, Vis-, and IR-absorption; •Raman and PL spectroscopy, including confocal geometry.

We studied damage threshold density of GaSe,  $GaSe_{0.9}S_{0.1}$ ,  $GaSe_{0.8}S_{0.2}$ , GaS, InSe and GaTe crystals under 4.5 ns pulses of Nd:YAG lasers, QUANTEL, BRILLIANT b (1064 nm) with the parameters: •repetition frequency: 10 Hz; •wavelength (energy): 1064 nm (850 mJ); 532 nm (360 mJ); 355 nm (170 mJ); 266 nm (60 mJ); 213 nm (13 mJ). Relatively high optical quality samples for measurements have been chosen with linear absorption coefficient at 1064 nm  $\alpha \leq 0.2 \text{ cm}^{-1}$ . GaSe samples were predominantly noncentrosymmetric  $\varepsilon$ - type (SG,  $D_{3h}^1$ ).

Polycrystalline ternary rare-earth doped crystals were grown in an evacuated quartz tubes from binary CaS (CaSe) and  $Ga_2S_3$  ( $Ga_2Se_3$ ) compounds and  $EuF_3$  as dopant. Process of obtaining pure materials included reaction ( $CaS + Ga_2S_3 \rightarrow CaGa_2S_4$ ;  $CaSe + Ga_2Se_3 \rightarrow CaGa_2Se_4$ ) from solid state phases taken from powders of binary components in stoichiometric proportion. Crystals were grown by chemical transport reaction method by using  $I_2$  as a transporter. Crystal structure was determined by X- ray diffraction and obtained data confirmed  $S_4^2$  space group and high quality of grown crystals. Room-temperature (RT) and 77 K PL were measured by exciting the spectra with Xe lamp (ДКСШ - 120) and registered by monochromator МДР – 23.

## RESULTS

Analyses of measurements confirmed, that grown GaSe crystals predominantly contain  $\varepsilon$ - type (2 layers per primitive unit cell, non-centrosymmetric  $D_{3h}^1$ SG), which is very useful in NLO applications. Some of grown GaSe crystals are shown in

**Figure. 1.**



**Figure. 1** Especially un doped and S doped (0.15 mass %) GaSe crystals grown by the Bridgman method.

Experimental results for optical properties and damage threshold of studied crystals are summarized in **Table 1**.

**Table 1.** Optical and NLO characteristics of GaSe and GaSe- type crystals studied at present work.

Crystal	SG	$\Delta E$ , eV, 300 K	Transparency Range, $\mu\text{m}$	$d_{\text{eff}}$ , $10^{-11}$ m/V	Damage Threshold, $\text{MW}/\text{cm}^2$
GaSe	$D_{3h}^1$	2.02	0.65 – 18	8	30
GaS	$D_{6h}^4$	2.80	0.48 – 14	2.35	28
InSe	$\gamma\text{-R3m}$	1.30	1.20 – 15	2.23	25
GaTe	$C_{2h}^3$	1.65	0.7 – 13	1.12	22

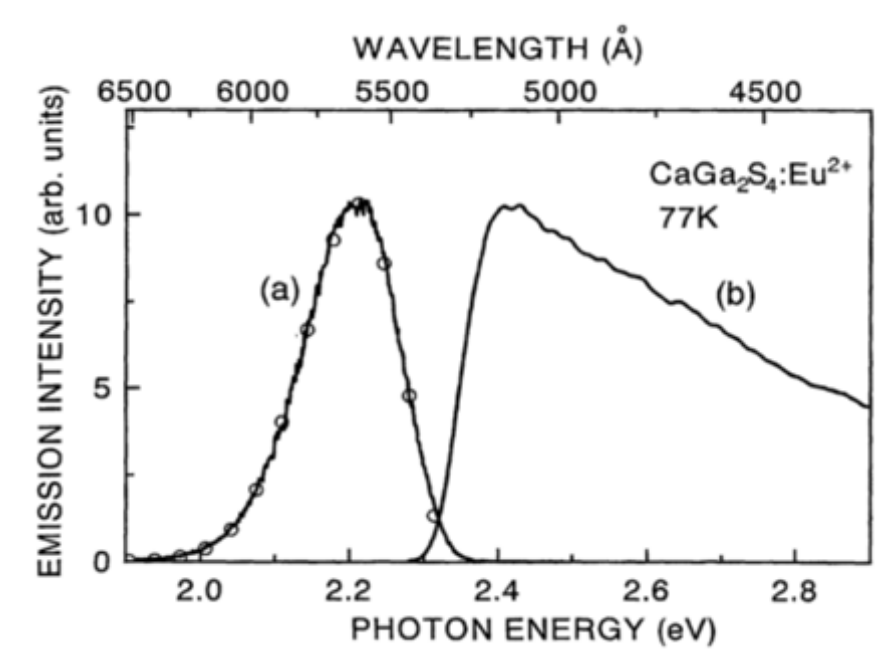
Analysis allowed to make conclusions, which are typical for all crystals: • crystals (especially doped and un-doped) reveal same specific damage peculiarities; •transmission of pure and doped crystals is reversibly decreasing down to ~20% due to transient effects including multiphoton absorption processes; •crystals doped with different elements – reveals different damage threshold; •the thickness of the damaged surface layer is of sub-  $\mu\text{m}$  scale and does not exceed of 1-3  $\mu\text{m}$  even at few  $\text{TW}/\text{cm}^2$  pumping; •under the ns pulses same type damages at the defect locations was observed as under the fs pump; •large scattering threshold of especially un-doped and doped GaSe is caused first of all by different type, number and size of defects; •improving of GaSe optical quality and lattice structure by doping seems to be good way to increase damage threshold.

RT experimental results for PL of  $\text{CaGa}_2\text{S}_4:\text{Eu}^{2+}$  and  $\text{CaGa}_2\text{Se}_4:\text{Eu}^{2+}$  are summarized in **Table 2**.

**Table 2.** RT parameters for PL of  $\text{CaGa}_2\text{S}_4:\text{Eu}^{2+}$  and  $\text{CaGa}_2\text{Se}_4:\text{Eu}^{2+}$ .

Crystal	Excitation band, nm	Type of transition in absorption	PL spectrum position, nm	Type of transition in emission
$\text{CaGa}_2\text{S}_4:\text{Eu}^{2+}$	302 – 470, 352, 398	$\text{Eu}^{2+}: 4f^7 \rightarrow 4f^6 5d$	554	$\text{Eu}^{2+}: 4f^6 5d \rightarrow 4f^7$
$\text{CaGa}_2\text{Se}_4:\text{Eu}^{2+}$	339 - 520	$\text{Eu}^{2+}: 4f^7 \rightarrow 4f^6 5d$	577	$\text{Eu}^{2+}: 4f^6 5d \rightarrow 4f^7$

Laser oscillations observed from  $\text{CaGa}_2\text{S}_4:\text{Eu}^{2+}$  is presented in **Figure 2**.

**Figure 2.** PL spectrum ((curve (b)) and laser oscillation curve ((curve (a)) from  $\text{CaGa}_2\text{S}_4:\text{Eu}^{2+}$  at 77 K.

Observed laser oscillations in crystals mentioned in **Table 2**, allowed to make several conclusions, which confirm, that these rare earth doped crystals have high potentiality for laser applications: •the emission is thought to be due to the transitions between  $4f^6 5d$  and  $4f^7$  in  $\text{Eu}^{2+}$  doped crystals; •the emission spectrum did not change noticeable between 20 and 300 K, except for a slight broadening of the width of the emission band at higher temperatures; •it is seen, that PL spectrum rises sharply from 2.29 eV and exhibits a peak at  $\sim 2.42$  eV and extends up to  $\sim 4.4$  eV; •the PL decay time was measured at temperatures between 20 and 300 K. Decay times obtained assuming a single exponential of 400 ns independent on radiative lifetime. Results obtained in the present research are in reasonable agreement with those presented in [9] for different laser lines.



## CONCLUSION

Especially un-doped and doped GaSe-, and GaSe- type crystals reveal same specific damage peculiarities and the thickness of the damage surface even at few TW/cm<sup>2</sup> pumping density does not exceed 1 – 3 μm. Large scattering threshold for these crystals (presented in literature) is caused by different type, number and size of defects.

Eu<sup>2+</sup> doped ternary thiogallate crystals CaGa<sub>2</sub>S<sub>4</sub>:Eu<sup>2+</sup> and CaGa<sub>2</sub>Se<sub>4</sub>:Eu<sup>2+</sup> reveal high intensity PL and laser oscillations properties with temperature stability.

Results of the present work show perspective of using studied crystals as an active media in lasers, including lasers useful for applications in modern information, measurements and control systems.

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## MODELING AND SIMULATION OF THE MECHANICAL SYSTEM TO PRODUCE FILE CUTTING EDGES IN AN INDUSTRIAL MACHINE

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### ABSTRACT

This paper deals with the research on the mechanical system used to produce file cutting edges (or cutting teeth). A theoretical model was carried out to perform kinematic and dynamic motion characteristics of the mechanical system (cam-follower-spring) of the cutting file machine. With the intent to validate the theoretical model an industrial machine was appropriately re-designed and instrumented to obtain some experimental data.

**Keywords:** Mechatronics; Instrumentation; Kinematics; Dynamics; Mechanical Design.

### INTRODUCTION

The experience demonstrates that the most efficient way to produce the file cutting edges is by penetration, due to the impact of a cutting tool which has a reciprocate motion. It should be highlighted that the cutting tool operating rate reaches 200 Hz. This process creates a plastic deformation on the file body, with the shape of sharp edges, which work as cutting edges. For getting this high frequency motion, the cutting bench of the machine has a cam which, due to its eccentricity, and when rotating, causes the elevation of the follower (also called pin throughout this work). The cylinder is elevated in this process, to which the chisel is fixed, and immediately falls down, impelled by the spring and its own weight. Figures 1 and 2 show two schematic drawings of the mechanical system used to produce files teeth.

The impact energy of the chisel depends on the relationship of the regulations of the spring force and the maximum distance between the chisel and the file that is adjusted by the presser foot.

The chisel describes a reciprocating motion that always reaches the same up dead point (maximum distance between the chisel and the file), because the pin/follower, attached to the cylinder (which moves the chisel), always passes by the tops of wheel-with-rebounds (cam). On the other hand, the down dead point of the chisel is variable, since it depends on the impact energy absorbed by the file body [1-2].

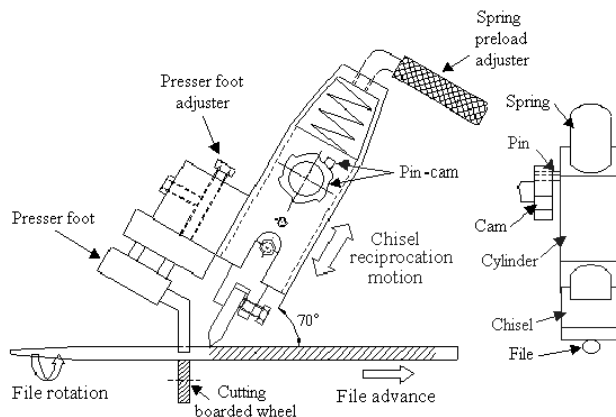


Fig. 1 - Schematic representation of the mechanical system (cutting bench).

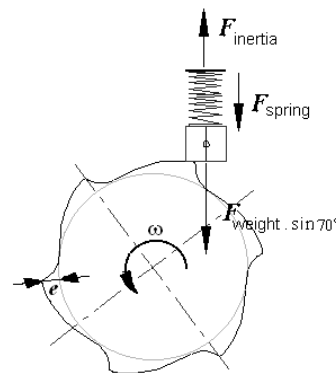


Fig. 2 - Kinematic configuration of the cam-follower mechanism.

### THEORETICAL MODEL

As it was referred previously, the file cutting operation is obtain through a peculiar type of cam, known as "wheel-with-rebounds", that originates two different phases for the follower movement (pin) - the elevation and the descent/fall. The

first one is obtained according to the principle of a cam follower mechanism, and the second movement is originated by a free fall body impelled by a spring until the chisel reaches the surface of the file body and hence the cutting operation. In the present work, the kinematic and dynamic analysis of the cam-follower mechanism was performed in three different stages that are following described:

1- Graphical and analytic method – determination of the equation of the follower/pin displacement as function of the cam profile.

2 - Study of the descent or fall phase - kinematic and dynamic analysis in order to obtain the contact point from which the pin follows the cam surface.

3 - Study of the rise phase - kinematic and dynamic analysis starting from the point of contact cam-follower.

This study does not account with the presence of the file body base during the follower descent movement, because the chisel penetration is governed by other mechanical principle (theory of plasticity), which is out of the scope of the present work.

Graphical and analytical analysis

A graphical method was used to determine the displacement curve of the follower. It was only considered a sixth part of the cam rotation because due to the rebounds that repeats for six times. The displacement curve (profile of the cam for each rebound) was obtained starting from one of the six points more eccentrics of the cam, considering increments of rotation of  $\pi/180$  rad ( $1^\circ$ ), using this way 60 relative static positions to the two bodies in contact (cam and follower).

The analytical solution was achieved through a polynomial function of the displacement curve obtained graphically. The best approximation for the polynomial function that expresses the follower displacement is a sixth degree polynomial, which can be written as,

$$s = 0,0028 - 0,0449.\theta + 0,2588.\theta^2 - 0,6651\theta^3 + 0,8966\theta^4 - 0,6072.\theta^5 + 0,1620.\theta^6 \quad (1)$$

where  $s$  and  $\theta$  are the follower displacement and the cam angle, respectively.

Figure 3 presents the follower's displacement curve (cam profile) obtained graphically and analytically, being verified the existence of a very good correlation (0,997).

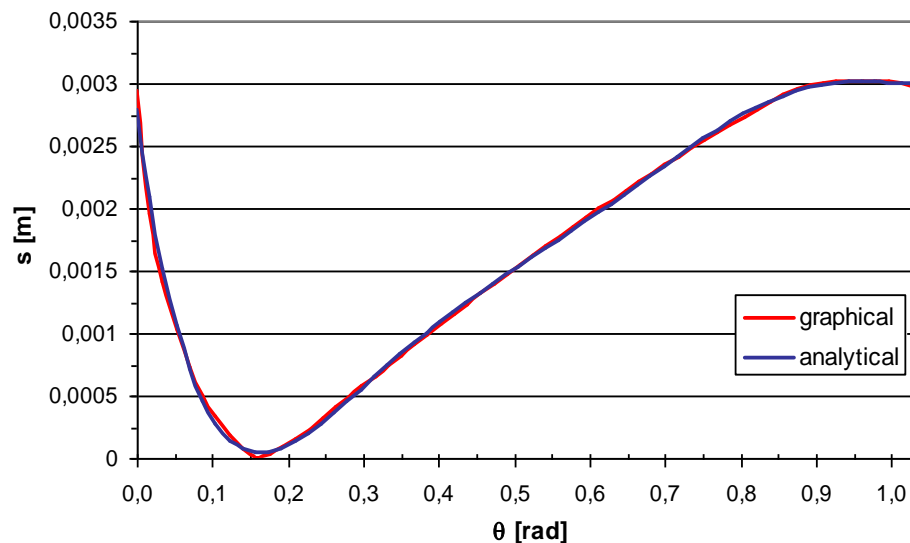


Fig. 3 - Displacement diagram of the follower for one rebound.

The follower displacement curve presented in Figure 3 is verified just in the case of occurring permanent contact between the follower and the cam surface. This situation doesn't happen in the reality due to the rebounds of the cam conjugated with the high rotation speed corresponding to the regular operation of the machine (1870 rpm).

It makes physically impossible the occurrence of permanent contact between the cam and the follower.

Figure 4 shows an animation sequence of a virtual simulation of the cam follower movement during the first instants after the follower reaches the up dead point, where it can be verify the existent "jump" on the end of the rising motion.



Fig. 4 - Illustration of the contact loss between the follower and the cam.

#### Analysis of the follower fall

The theoretical analysis of the descent was performed according to the principle of a fall body forced by a spring, until the chisel reaches the surface of the file. This analysis was achieved considering the follower descent movement uniformly accelerated in small intervals of time. Figure 5 presents the flowchart of the theoretical model elaborated to predict the follower motion.

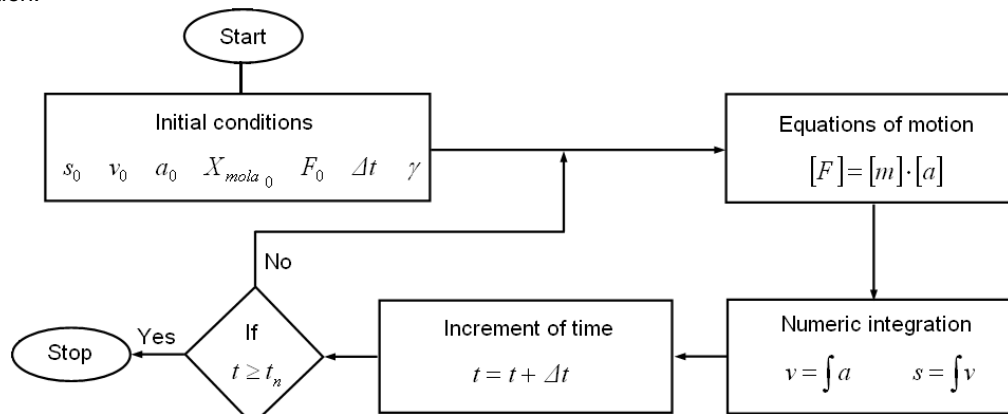


Fig. 5 - Flowchart describing the dynamics of cam-follower fall motion.

By knowing the initial state of variables: cam rotation, elastic spring constant  $K_{spring}$ , pre-tension of the spring  $F_{spring \text{ pre-tension}}$  (with the follower in the point more eccentric of the cam), the follower mass  $m$ , angle of inclination of the cutting bench  $\gamma$  (see figure 1), the values of displacement  $s$ , velocity  $v$ , acceleration  $a$ , deformation of the spring  $X_{spring}$  and applied force in the follower  $F$ , can be calculated for the instant initial  $t_0$ , by using the following equations:

$$s(t_0) = s(\theta = \pi/3) \quad (2)$$

$$v(t_0) = v(\theta = \pi/3) \quad (3)$$

$$a(t_0) = a(\theta = \pi/3) \quad (4)$$

$$X_{spring}(t_0) = X_{spring\ pre-tension} = \frac{F_{spring\ pre-tension}}{K_{spring}} \quad (5)$$

$$F(t_0) = K_{spring} \cdot X_{spring}(t_0) + m \cdot g \cdot \sin(\gamma) + a(t_0) \cdot m \quad (6)$$

The dynamic analysis is repeated for the next time steps  $t_i$  ( $i = 1, 2, 3, \dots, n$ ), corresponding the instant  $n$  to the initial moment of contact between the follower and the cam after the descent/fall. The acceleration, the displacement and the follower velocity are obtained for the following equations, considering an interval of time  $\Delta t$ , which corresponds to  $\pi/180$  rad ( $1^\circ$ ) of cam rotation, that is,

$$a(t_i) = -\frac{F(t_{i-1})}{m} \quad (7)$$

$$s(t_i) = s(t_{i-1}) + v(t_{i-1}) \cdot \Delta t + \frac{1}{2} \cdot a(t_i) \cdot \Delta t^2 \quad (8)$$

$$* X_{spring}(t_i) \geq 0 \Rightarrow X_{spring}(t_i) = X_{spring}(t_{i-1}) - [s(t_{i-1}) - s(t_i)] \quad (9)$$

$$* X_{spring}(t_i) < 0 \Rightarrow X_{spring}(t_i) = 0$$

$$v(t_i) = v(t_{i-1}) + a(t_i) \cdot \Delta t \quad (10)$$

$$F(t_i) = K_{spring} \cdot X_{spring}(t_i) + m \cdot g \cdot \sin(\gamma) + a(t_i) \cdot m \quad (11)$$

Note\*: To avoid the occurrence of negative values of  $X_{spring}(t_i)$ , what is physically impossible with the *Belleville* spring because it is working in tension. This is due to the fact that the values of pre-tension typically adjusted for the spring, which determine its deformation value  $X_{spring}(t_0)$ , are less than the maximum displacement of the follower  $s(t_0)$ , that is 3 mm (value of the eccentricity of the cam  $e$ ).

This analysis allows obtaining graphically the initial contact point between the follower and the cam. For that, it was necessary to intercept the curves in order at the time of the follower fall displacement (obtained for the analytical method shown in the flowchart of Figure 5) and the follower-cam displacement (analytical – Figure 3). Theoretically the follower follows the cam surface just starting from the point of interception of the two curves. It shall be remained that this study was performed considering the inexistence of the body base of the file during the descent phase, what corresponds to the obtaining of the maximum follower displacement/stroke.

### Experimental Measurement System

In order to validate the theoretical model it was necessary to know how the values of the main parameters were related to the file teeth production, as well as the follower displacement and the spring force the displacement of the cutting beater. This type of sensor has a good accuracy and works quite well even under severe conditions, such as of high vibrations/frequencies and accelerations, because the measurement is performed without direct contact [3-7]. To measure the spring force a piezoelectric force transducer was chosen, due to the fact that this technology is the most appropriated to measure dynamic forces at high frequencies [8-9]. Figure 6 shows the transducers' arrangements in the cutting bench of the file machine. The detailed description of the instrumentation of the cutting file machine can be found in references [10-11].

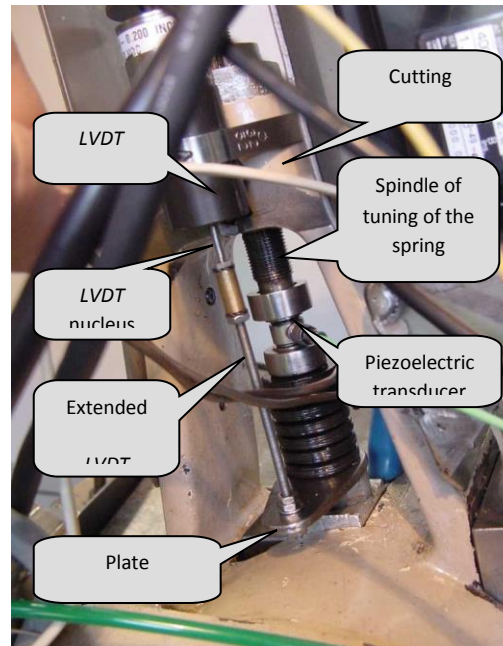


Fig. 6 - Layout of the transducers.

A desktop PC, with a data acquisition board and specific software developed in LabVIEW environment, was employed to acquire, store and analyse the acquired data. This software were developed with base in a computing design performed to achieve the automatic machine control, that realized the acquisition and treatment of the transducers data, as well as the control of the main regulations of the machine, in order to keep the depth of penetration of the chisel under values that guaranteed the production of the teeth in the quality limits  $\square 11 \square$ .

## RESULTS AND DISCUSSION

### Theoretical results

The kinematic analysis of the follower descent motion was performed to study the influence of the main parameters that controls its behaviour, namely: the cam rotation, the pre-tension of the spring and the follower mass. Through the obtained graphs it can be determined the point of interception of the curves previously referred, as well as, the curves of velocity and acceleration of the follower.

### Influence of the cam rotation

This analysis was performed with a spring pre-tension (elastic constant 240 N/mm) of 335 N, that corresponds to a typical value of machine operation, and considering the follower mass of 0,5 kg. Figures 7, 8 and 9 present the results for cam rotation, respectively, for 380, 1120 and 1870 rpm, being this last case the most common speed of machine operation.



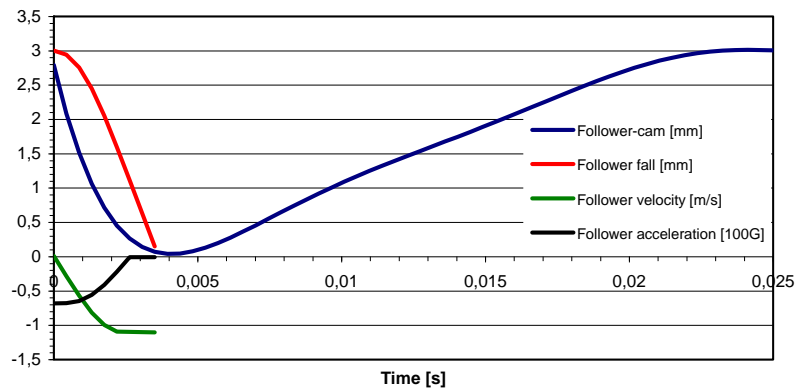


Fig. 7 - Global results for cam rotation speed of 380 rpm.

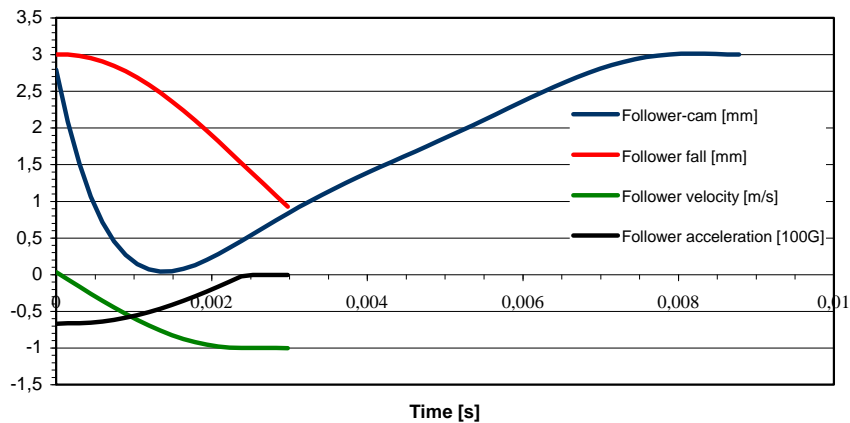


Fig. 8 - Global results for cam rotation speed of 1120 rpm.

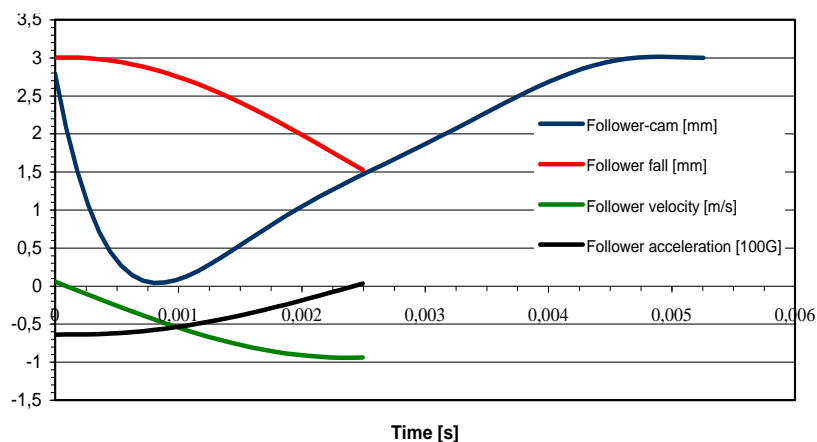


Fig. 9 - Global results for cam rotation speed of 1870 rpm.

Table 1 presents the values of the more relevant kinematics parameters involved in the cutting operation of the

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industrial file machine used in this study.

Table 1 – Main results obtained of the analysis of the influence of the cam rotation.

Cam rotation [rpm]	Cam rotation angle (contact cam-follower) [°]	Follower fall stroke [mm]	Maximum velocity [m/s]	Maximum acceleration [100G]	Maximum kinematic energy [J]
380	8	2,9	1,1	-0,67	0,3025
1120	20	2,2	0,99	-0,66	0,2450
1870	28	1,5	0,94	-0,63	0,2209

It can be concluded, analysing Figures 7, 8 and 9 and Table 1, that when the cam rotation is higher the displacement/stroke of the follower descent/fall decreases. Due to this reason, the cutting frequency operation of the machine is limited, associated to the cam rotation speed, because it is necessary a minimum stroke for the chisel to obtaining files with quality teeth (acceptable chisel penetration depth).

Additionally, it can be concluded that increasing the cam rotation, due to the occurrence of smaller displacements, the velocity, the acceleration and the kinetic energy of the follower decreases.

#### Influence of the spring pre-tension

This analysis was done considering the same follower mass of 0,5 kg and a cam rotation speed of 1870 rpm. Figures 10 and 11 present the results obtained, respectively, for the spring pre-tension of 200 and 400 N. Table 2 shows the main values of the most relevant parameters of this study.

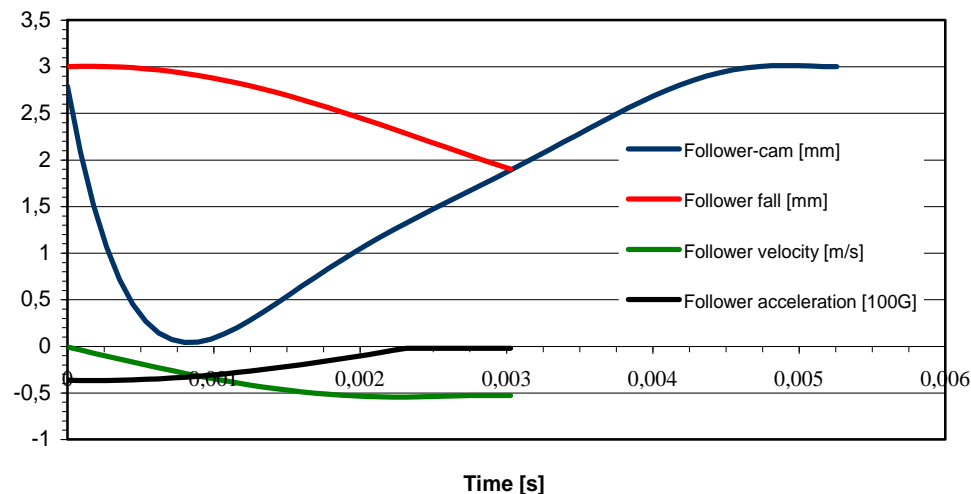


Fig. 10 - Global results for spring pre-tension of 200 N.

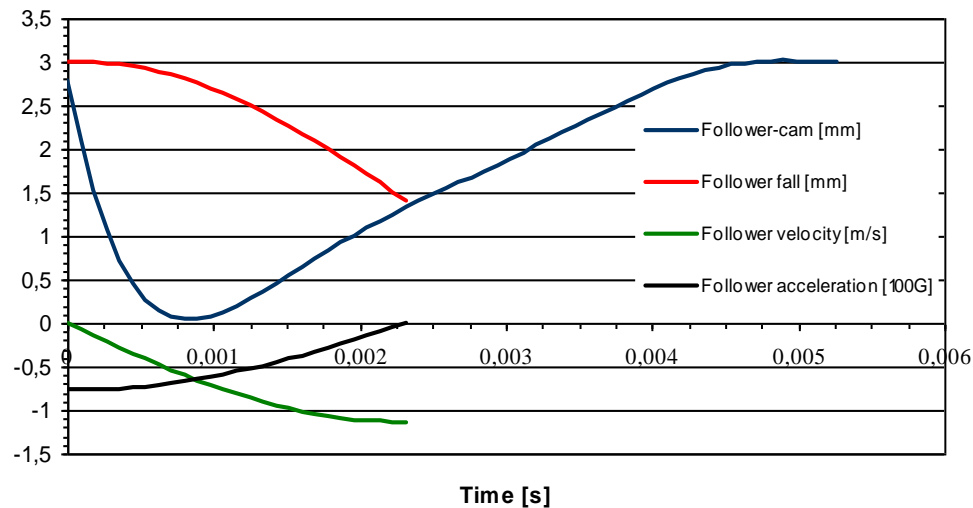


Fig. 11 - Global results for spring pre-tension of 400 N.

Table 2 - Main results obtained of the analysis of the influence of the spring pre-tension.

Spring pre-tension [N]	Cam rotation angle (contact cam-follower) [°]	Follower fall stroke [mm]	Maximum velocity [m/s]	Maximum acceleration [100G]	Maximum kinematic energy [J]
200	33	1,1	0,53	-0,37	0,0702
335 (Fig. 9)	28	1,5	0,94	-0,63	0,2209
400	26	1,6	1,13	-0,77	0,3192

#### Influence of the follower mass

This analysis was performed taking into consideration the cam rotation speed of 1870 rpm and a spring pre-tension of 335 N. Figures 12 and 13 present the results obtained, respectively, for the follower mass of 0,3 and 0,4 kg. Table 3 summarize the values of the most relevant parameters of this analysis involved in the cutting operation.

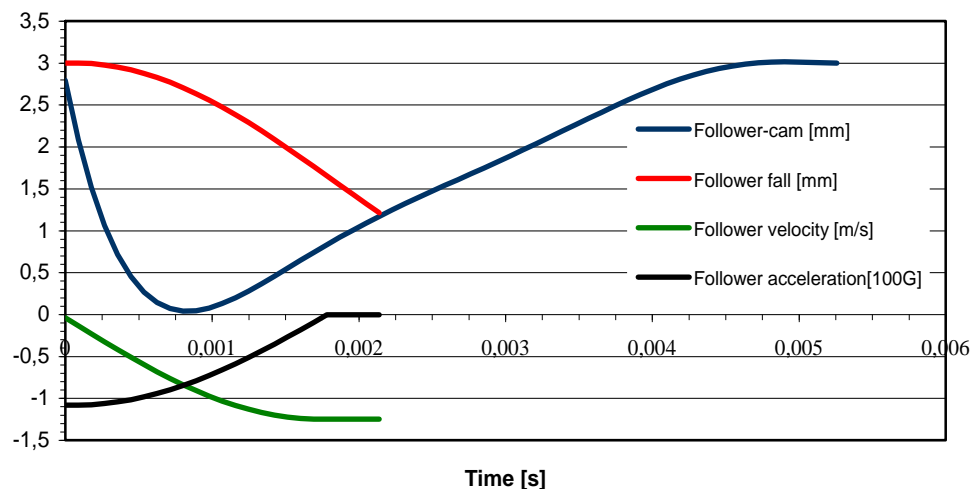


Figure 12 - Global results for follower mass of 0,3 kg.

Analyzing the results presented in Table 3 it can be concluded that the follower kinetic energy is independent of the mass, because the influence of mass is compensated by the increase of the follower velocity.

Figure 14 shows the cam rotation angle where the contact cam-follower occurs after the fall, as function of the three variables studied that is, cam rotation, spring pre-tension and follower mass. This parameter is very important because it determines the descent displacement of the follower/chisel. As referred previously, for obtaining a correct depth of penetration, a minimum stroke for the chisel must be obtained through the mechanism cam-follower.

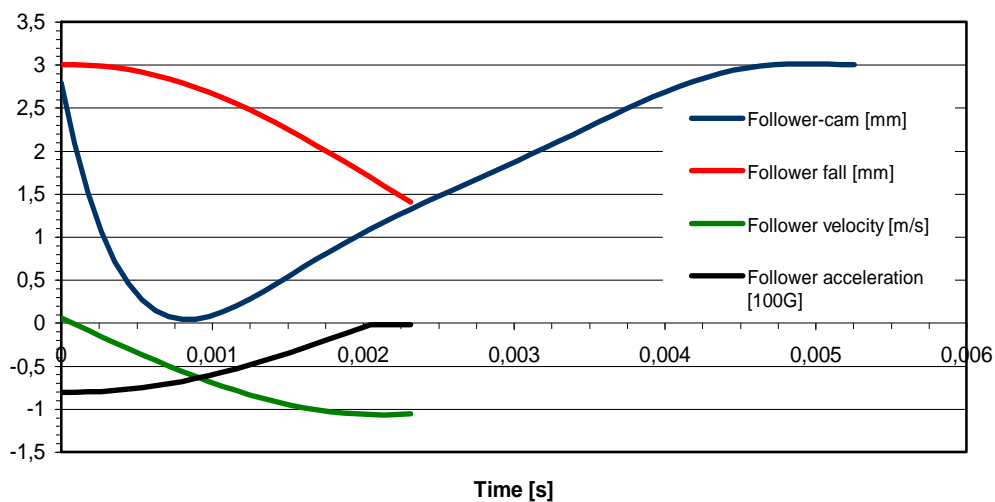


Fig. 13 - Global results for follower mass of 0,4 kg.

Table 3 - Main results obtained of the analysis of the influence of the follower mass.

Follower mass [kg]	Cam rotation angle (contact cam-follower) [°]	Follower fall stroke [mm]	Maximum velocity [m/s]	Maximum acceleration [100G]	Maximum kinematic energy [J]
0,3	23	1,8	1,23	-1,08	0,2269
0,4	26	1,6	1,06	-0,80	0,2247
0,5 (Fig. 9)	28	1,5	0,94	-0,63	0,2209

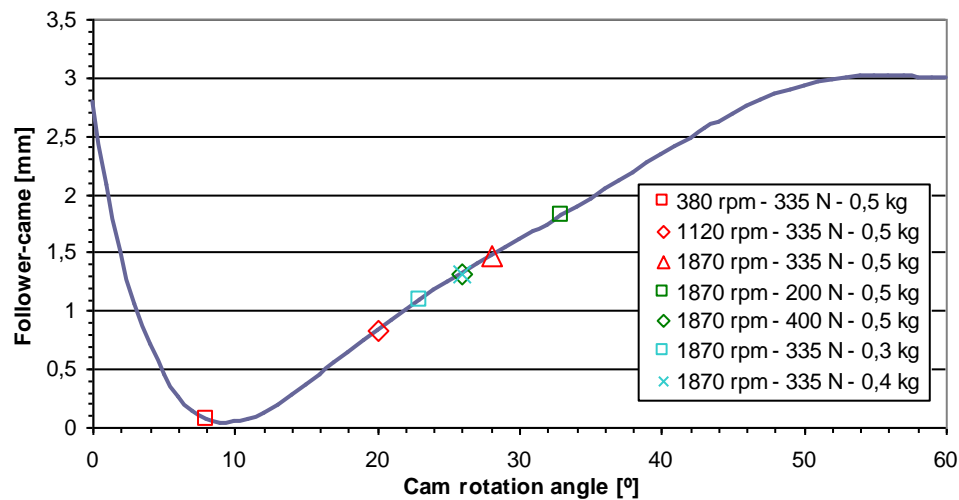


Fig. 14 - Theoretical location of the initial contact cam-follower.

It can be concluded that the main limitation of the machine cutting frequency is associated with the reason of the increase of the cam rotation to implicate a decrease of the descent stroke of chisel. This fact can be contradicted with the increase of the pre-tension of the spring and the decrease of the follower mass. They are limited, respectively, due to the resulting kinetic energy (occurrence of excessive cutting) and to constructive reasons.

### Experimental results

Figures 15 and 16 show typical results obtained by using the experimental and theoretical approaches with the typical values of operation of the cutting file machine.

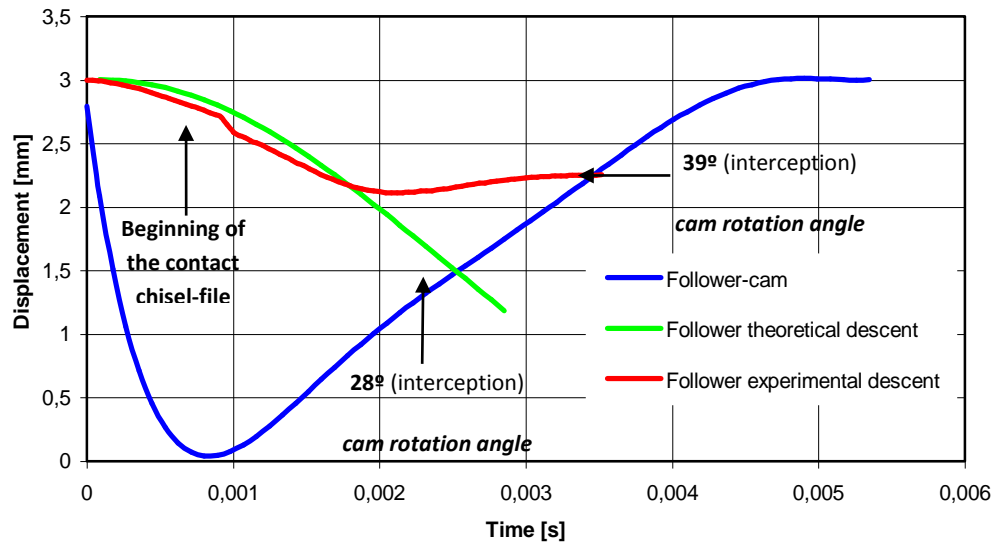


Fig. 15 - Theoretical model results versus experimental data for the follower descent.

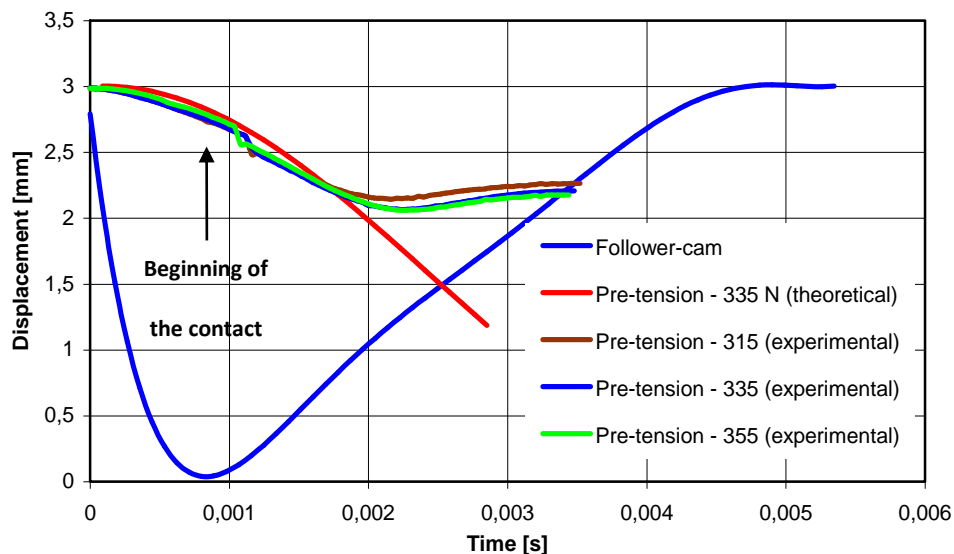


Fig. 16 - Theoretical model results versus experimental data for the follower descent for different values of spring pre-tension.

From the results presented in Figures 15 and 16, it can be concluded that a very good correlation is obtained between the theoretical and experimental results for the follower descent until the beginning of the contact between the chisel and the file base body.

## CONCLUSIONS

The system currently used to produce files (mechanism, cam-pin-spring) is a very efficient way to generate discontinuous teeth, being the more effective for the forces and, especially, for the rates involved in the cutting process.



The maximum frequency that the chisel can operate is conditioned by the mass of the cutting body of the machine, commonly designated by crusher, and that it is composed by the pin, cylinder and chisel.

The main restriction of the machine cutting frequency is that the increase of the cam rotation implicates a decrease of the descent displacement of the chisel.

The cutting frequency can be increased with the decrease of the follower mass, due to the reason of the follower kinetic energy being almost independent of its mass.

The measurement system used to evaluate the process behavior has been developed and proposed. The waveforms obtained suggested that this system is adequate to measure the main parameters involved in the cutting operation and to understand the process itself.

The present research has been demonstrated to be successful using the theoretical model proposed to describe the follower descent.

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## MATHEMATICAL MODELS FOR COMPUTERIZED CONTROL SYSTEM

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### ABSTRACT

The software is a set of mathematical methods, and algorithms of information processing, which used in creating the control system. When designing control systems, Initial data for the design of control system.

The tasks of the computerized control system are understood as a part of the computerized functions of the computerized control system characterized by the outcomes and outputs in specific form. control function is: commutative action for computerized control system, aimed to achieve a criterion goal. Depending on the properties of the process and their mathematical description can be combined into different classes; This paper shows the designing the mathematical models which need to computerized control systems (models (3) – (8)). In the same time this paper shows the main methods which were used to formulate the mathematical models as:

- Stochastic and deterministic;
- One dimensional and multidimensional;
- Linear and nonlinear;
- Static and dynamic;
- Stationary and non – stationary;
- With distributed and lumped parameters.

### ABSTRACT

**OBJECTIVE:** Design a new model for computerized control systems.

**METHODS:** Stochastic and deterministic; one dimensional and multidimensional; linear and linear; static and dynamic; stationary and non- stationary; distributed and lumped parameters.

**RESULTS:** This paper shows the designing the mathematical models which need to computerized control systems, by using many methods.

**CONCLUSION:** The software is a set of mathematical methods, and algorithms of information processing, which used in creating the control system. When designing control systems, Initial data for the design of control system. The tasks of the computerized control system are understood as a part of the computerized functions of the computerized control system characterized by the outcomes and outputs in specific form. control function is: commutative action for computerized control system, aimed to achieve a criterion goal. This paper shows the designing the mathematical models which need to computerized control systems.

**Keywords:** control system, Algorithm, Information processing, Criteria, Mathematical model, Characters.

### INTRODUCTION

The software is a set of mathematical methods, and algorithms of information processing, which used in creating the computerized system. When designing computerized systems (CS) , Initial data for the design of CS software system is a list of functional task includes the task and function of computer aid design (CAD), computerized enterprise management system and etc.

In this way, part of software of CS including mathematical methods, and means allows us to solve all given tasks a special place in the composition of mathematical support is occupied by mathematical models of continuous technological process, used to manage them. From the mathematical point of view, every continuous technological process can be represented as a control objects.

### FORMULATION OF THE PROBLEM

The tasks of the computerized control system are understood as a part of the computerized functions of the computerized control system characterized by the outcomes and outputs in specific form. Control function is: commutative action for computerized control system, aimed to achieve a criterion goal.

Each task in computerized control system (figure 1) can be formulated at meaningful level but to solve it with the help of computational tools required mathematical description of the problem, i.e, formal presentation of its task  $Z$  may be defined as a set of raw data  $I$  and decision  $R$ :

$$Z \rightarrow \langle I, R \rangle \quad (1)$$

Solution can be obtained by using method, which implemented in the form of the computation chart (algorithm  $A$ ) or set of algorithms. Solution  $R$  can be obtained by the form:

$$R = M[I] \text{ or } R = A[I], \quad (2)$$

Thus, formulation of the problem in computerized control system involves determining  $I$ ,  $R$ , and selection of justification  $M$ . Description of the problem statement in computerized control system performed with accordance [1,2,3,4].

In the content of each task is: the purpose of the task, economic and mathematical model of the problem and method its solution, functional interconnectivity problems with information base of computerized control system and enterprise services, how to implement task for computer, reliable solution approximate of the efficiency objectives (expected performance, the cost of machine resources, cost of labor time and material resources for its development).

Content of the problem is included in documents (description of the problem statement) and description of the algorithms, who are working a document and design systems (Designers and programmers) and for employees of the enterprise management services.

Each document developed at the stage of technical design of MS and if necessary may be combined in one.

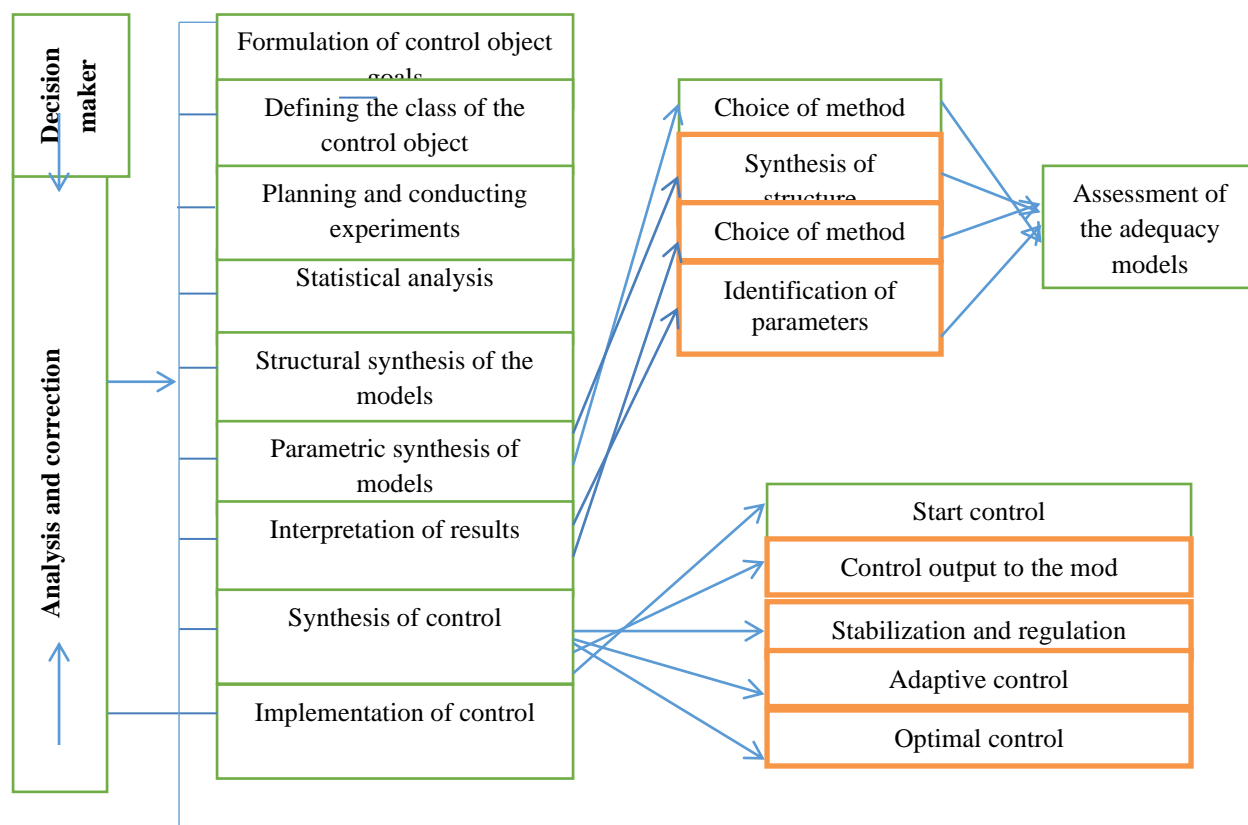


Figure (1) – levels of technological management object.

Realized of software and algorithmic support in MS is a software. A general description is made on the technical design stage and takes the form of a document (description of the software) of ICMS. Fully developed software is described in the detailed design stage and shall be in accordance with the requirements of the program document. The main section of the document (description of the problem statement):

1. Characterization of complex tasks;
2. Output information;

### 3. Input information

In CMS, engineering process is the main problem of mathematical models of technological process, are used to management the next tasks. Statement of the problem object management can be formulated follows:  
Object is described input  $X$ ; i.e. state of the environment, and output  $Y$ , i.e. state of the object

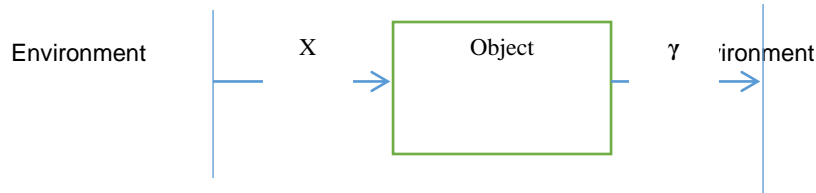


Figure (2)

State of the object  $Y$  depends on the environment  $X$ ;

$Y = f^o(X)$ ; where  $f^o$  – characterizes the relationship between input and output object.

Source management purposes the system designer, which forms the purpose in accordance with their needs. If the state  $Y$  not satisfied with the developer recently formative influence on the object, i.e. implements management. If  $Z^m$  indicated the desired goal, then verify the objective  $Z^m$  the object can only be for the conditions  $Y$ . For this state  $Y$  object should be expressed in the form  $Z = \psi(Y)$ . If  $Z = Z^m$ , you must create a management system, which is implemented to purpose  $Z^m$ .

For the implementation of management necessary to find the factors, they may be input object. If we denote management  $V$ , then state of an object depends on the  $X$  and  $V$ :  $Y = f^o(X, V)$ . To formalize the description of their content management problem statement must identify input information  $I = \langle X, Y \rangle$  and the desired result  $V: Z = Z^m$ . The next step after the formulation of the problem is the formulation of mathematical models [5, 6, 7].

### PROBLEM SOLUTION

Depending on the properties of the process and their mathematical description can be combined into different classes; next, we will talk about referring an object to a particular class according to certain feature.

The following classes of process stand out:

- Stochastic and deterministic;
- One dimensional and multidimensional;
- Linear and nonlinear;
- Static and dynamic;
- Stationary and non – stationary;
- With distributed and lumped parameters.

Model of technical process presented in general form:  $Y = F(X)$ ; characterized by a structure  $s_t$  and parameters  $C$ ; i.e. operator  $F = \langle s_t, C \rangle$ . Let's consider the basic models taking into account that, in each class the defining one is one of the properties;

Multidimensionality, linearity, stochastic, dynamism, stationary, distribution.

The multidimensionality of an object is determined by the number of parameters, requiring control and regulation the larger this number is the more complex the subject. Some objects (power units and systems) are sometimes described in several tens and hundreds of parameters.

If, addition the decomposition into the system of linearly independent functions or higher – order differential equation, this dramatically increase the dimension of the problem. It is extremely difficult to obtain a complete mathematical description of such objects.

A linear is called an object, the reaction of with is sum of 2 impacts  $x_1(t)$  and  $x_2(t)$  equal to the amount of reaction to these impacts:

$$F[x_1(t) + x_2(t)] = F[x_1(t)] + F[x_2(t)] \quad (3)$$

The model of such an object is generally described by a relationship

$Y = \sum_{i=1}^n C_i x_i + \sum_{j=1}^m C_{n+j} V_j$ , where  $x_i$  – and  $V_j$  – accordingly the guided controlled input of the object.

Stochastic associated with presence of objects and among various uncontrolled factors, the combined effect of which can simulate a statistical one. The structure of the models of such an announcement

$$Y = F(x, V, E, (t)) \quad (4)$$

Where  $E(t)$  – random process, modulating the existing uncertainty of the object and environment. This uncertainty can be due either to a rapid change in the state of the object, or interference, folding to measure the input and output of the object. Mathematical assuming that all deviations from regulation on the behavior of the object forms random interference  $E(t)$ , the mode takes the form

$$Y = F(X, V) + E(t) \quad (5)$$

Dynamic is present in those cases, when the mathematical description of the process is insufficient representation in the form of a function, it is necessary to use different and integral calculi.

An example of statically model is the decomposition of the output of an object  $Y$  by a system of linearly independent functions  $\{\varphi\}$  inputs  $X, V$ :

$$Y = \sum_{i=1}^K C_i \varphi_i(X, V), \quad (6)$$

Where  $C_i$  – model parameters.

An example to a dynamic structure is a model in the form of linear differential equation

$$\frac{d^p y}{dt^p} + a_{p-1} \frac{d^{p-1} y}{dt^{p-1}} + \dots + a_1 \frac{dy}{dt} + a_0 y = B_2 \frac{dt}{dt^2} + \dots + B_n X \text{ or of course the difference equation}$$

$$y_z = \sum_{i=1}^p d_i y_{z-1} + \sum_{j=1}^L L_j X_{z-j}; \text{ where } a_i, B_j, d_i, L_j - \text{model parameters; } z - \text{moment of time.}$$

The nonstationary of object is associated with a deterministic or random change in the time of operator  $F$ .

If this change occurs slowly enough, in type Driff parameters, it can be ignored, since the model correction (adaptations) process at each step of control allows adjust a model and thereby compensate of Driff. With a rapid change in character  $F$  nonstationary must be taken into account in the structure of the model and types of dependence  $F$  and  $C$  from time  $t$

$$Y = F_t(X, V, C(t)) = F(X, V, C, t) \quad (7)$$

Where the parameters can depending  $C = C_0 + C_i(t)$ ;

The reason for nonstationary of the object may be its again.

The distribution of parameters usually places in objects, extent territorial, in this case the parameter of the object is a function of the other parameters most often a long object  $L$ , i.e. the model takes the form

$$Y = F_L(X, V, C) = F(X, V, C, L) \quad (8)$$

Models of the form (3) – (8) in addition to defining the structure it is necessary to estimate the parameters  $C$ , mathematical operator used to evaluate  $C$ , is the theory of optimal estimation.

Mathematical methods of model synthesis (3) – (8) they are called identification methods.

## CONCLUSION

The tasks of the computerized control system are understood as a part of the computerized functions of the computerized control system characterized by the outcomes and outputs in specific form. Control function is: commutative action for computerized control system, aimed to achieve a criterion goal. Depending on the properties of the process and their mathematical description can be combined into different classes; This paper shows the designing the mathematical models which need to computerized control systems( models (3) – (8)). In the same time this paper shows the main methods which were used to formulate the mathematical models as:

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## TECHNOLOGY DRIVES THE EVOLUTION OF MEETING CULTURE

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### ABSTRACT

Many of us remember the days when meeting room technology was nothing more than an overhead projector for displaying transparencies. That is a far cry from today's technology, which enables meeting participants to manage a baffling variety of content sources and devices. The purpose to explore this technological evolution and focuses on how meeting room technology is moving into a new phase where access to modern meeting room technology solution is paramount.

**Keywords:** Collaborative Meeting Spaces, Modern Meeting Room Technology, Meeting Room Design Concept, Meeting Room Equipment

### INTRODUCTION

From a historical and sociological point of view, choosing the most appropriate places to convene has had, and continues to be part of, its own evolutionary process. Cavemen had their caves, romans politicized in forums, various tribes had their own versions of strategically and logistically apt gathering points to discuss trade, etc., and the post-industrialization period coined the term to which we still commonly refer to as the meeting room.

Towards the end of the last century, meetings mainly took place in one location. People would sit around a table, exchange information and present ideas. In the world of business, this would typically be done in an executive's office or a specially designated conference hall. In the past, managers would meet separately, while nowadays businesses are moving from this top-down directing approach to a more inclusive, collaborative workforce that engages all employees and aligns them with the organization's aims.

This change is impacting how companies design their workspaces, and, consequently, the meeting room itself is evolving. The days of giant desks, corner offices and over-sized suits with suspenders have drawn to a close and new factors are emerging that need to be considered when planning meetings and the latter's locations.

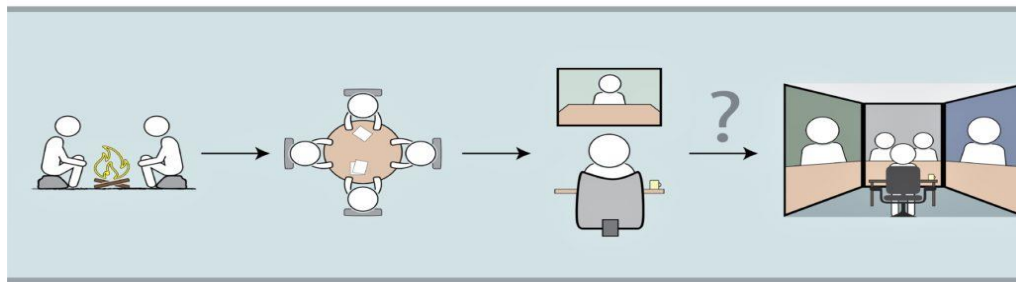
As Earth's population is growing like billy-o, it's not surprising for statistics to show that a staggering 55 million meetings take place every single day, and approx. 37% of work time is spent at these corporate get-togethers. Not all of the latter, however, are physical.

To meet the demands of this expansion, technological advancements over the last 25 years have triggered enormous changes. Global businesses have deployed video conferencing and telepresence technology to enable visual communications as well as to facilitate external collaboration.

Although virtual meetings, supported by various types of gadgetry, have made it much easier for people scattered around the planet to meet without a room, this has not resulted in a decline of the need for physical meeting rooms. Quite the opposite in fact. We've entered a Millennial-driven "people-centric era", which means internal face-to-face meetings remain a definite must in any company.

### THE EVOLUTION OF THE MEETING

Since the beginning of social civilization, people have held meetings in some form or another. One could argue the first "meetings" were held around a campfire, discussing a tribes' plans for the next season and where they would move. Over time, as humans settled and formed cities, these meetings moved into a room. The technological revolution of the past 60 years however, has had a drastic impact on how humans meet and interact inside and outside of these rooms.

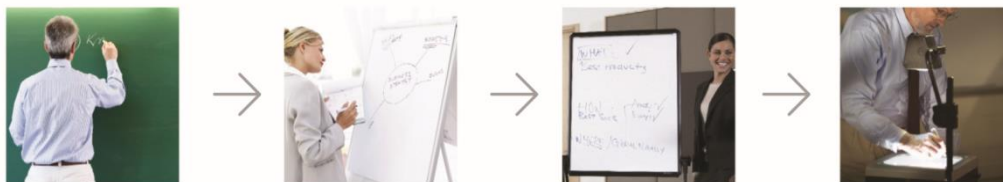


From the past to the future

Generally, we can consider below stages of the meeting room technology evaluation

### Analog Meeting Room

Some of us can remember the glory days when a meeting presenter would walk to the front of the room, grab a piece of chalk or dry-erase marker, and proceed to make unintelligible scribbles that would have contained vast wisdom had we been able to decipher them.



The Early Evolution of Meeting Room Technology

In those days of the Analog Meeting, the tools of the trade were simple: chalkboards, flip charts, overhead projectors and dry erase boards among the most popular. To prepare for a presentation frequently meant printing and handing out a packet of documents and then realizing that you had left out something important.

### Digital Meeting Room

The arrival of the laptop computer in the 1990's ushered in a new era of collaboration. The mainstay of the conference room during this period was the combination of a laptop, a projector, and a deck of PowerPoint slides. Again, many of us have fond memories of this combination, and of enduring such frustrations as not being able to get the image to focus, not knowing the function key combination to transfer the image from the laptop to the projector, and trying to recover from the sudden burnout of the projector's bulb.



The Later Evolution of Meeting Room Technology: Meetings Go Digital

Despite all the frustrations, this era did help establish a new type of collaboration where meeting participants could evaluate and modify content as they discussed it. Content in meetings became more fluid, more flexible. And PowerPoint was crowned the King of Content.

### Multimedia meeting

Over the many years of delivering PowerPoint presentations via a laptop and projector, meeting presenters and attendees increasingly wanted to leverage more types of content: A clip from a DVD. Real-time stock reports. Broadcast audio and video. Files from the corporate network. Meetings were evolving beyond PowerPoint and into a new age where content was rich and diverse.



The Meeting of Today: Fueled by Multimedia

This evolution from Laptop + PowerPoint to a wide variety of content sources represented the final step in the transition from digital meetings to multimedia meetings. The differences are outlined below

	<u>Digital meeting</u>	<u>Multimedia meeting</u>
<b>Content</b>	PowerPoint slides and other Office documents	Office documents, PDFs, video clips, audio clips, web-based content, broadcast audio & video
<b>Devices &amp; other content sources</b>	Laptop	Networked PCs, web-based storage apps (e.g. Dropbox), laptops, tablets, smartphones, USB drives, DVDs, Blu-Rays, CD-ROMs
<b>Room technology</b>	PCs, overhead projectors, speakerphones, video conferencing systems	LCD Display, networked room PCs, dedicated presentation systems, speakers, speakerphones, video conferencing systems, document cameras, user interfaces (control panels & keypads), VCRs, AV controllers
<b>Expectations</b>	Technology is a nice benefit as long as I can get it to work	Technology is a necessity and it must work

### MODERN MEETING ROOM TECH TO CONSIDER

No matter how much we sometimes wish we could replace meeting rooms, they are often the best place to get a fair amount of work done. Even in a digital era, face-to-face meetings are still extremely valuable, and that means it's worth it to invest in modern conference room technology and meeting room design that can make your time spent together with your team more effortless and seamless than ever before. The design or re-design of your meeting and conference rooms and use of technology is important to the success of your employees as well as meetings with business guests and clients.

How many times have you been in a meeting room and everyone is waiting to get started, only to be held up by some critical piece of technology that isn't working correctly? Multiply those minutes (or hours) by the number of people in the room, and you can see why it's so important to make sure that you have the best setup you can possibly get: When you consider the cost of time, you simply can't afford not to.

The right meeting room technology enables the seamless connection between all these parties. To get the most out of your collaborative efforts and maximize your efficiency, there are a few key pieces of meeting room audio visual technology critical to success. You have three choices when it comes to connectivity:

- Wired
- Wireless

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- A combination of wired and wireless.

Both wired and wireless connectivity have their pros and cons, and ultimately it will come down to a matter of personal preference.

Many people prefer wireless connectivity simply because it eliminates the clutter of cords, but table inserts however can discretely hide wired connectivity that would provide a typically higher-quality and more stable presentation experience. Connected table boxes can also include electrical outlets for charging or a wired connection for plug and play. If you want to be able to screen share without plugging in, a wireless connectivity solution may be the right choice for you.

We can consider the several main components, which need to bring your workplace into the modern day.

### Displays

The first thing people notice when walking into a meeting and conference room is the display. This is the “visual” part of conference room audio visual, and it is one of your main collaboration tools. The display enables you to see colleagues in other locations, view presentations, and screen share from laptops, tablets and smartphones.

Single displays are a go-to choice for many small conference rooms. Dual displays are a popular option, especially for companies that are heavy video-call users. These dual, or even tri, displays allow screen sharing and video conferencing to share the spotlight.

When on a video call with a single display you will likely have picture in picture view capability. This means you get to choose between seeing the content that is being shared or the other people on the video call (also called the far side) in the large view. Content is often chosen for the large-screen since it typically drives the meeting’s conversation. Whichever is not in the large view is shown in a small square at the bottom of the screen. Since content is usually in the large view, people on the call are shown in a small frame. In a conference room, this can reduce one of the main benefits of video conferencing- seeing people!

Dual displays offer a solution to the picture in picture view. Meeting attendees see both the content being presented and the other video participants, each on their own full-screen. Instead of choosing between content and people, you can see both clearly. This solution helps collaboration by enabling the team to see nuances like facial expressions during the presentation.

### Interactive Whiteboard

If you host brainstorming sessions in your office or work with people that are visual learners (around 65% of people), an interactive whiteboard can be a valuable tool to add to your system of meeting and conference room equipment. Interactive displays allow you to write directly on the board in various colors, annotating over web pages or documents.

In addition, video conferencing platforms enable users to whiteboard while on the call and share to other participants in real-time or after the conference has completed. This can be helpful if your employees present over video conferencing and can create a more engaging experience for the others on the call.

### Audio or Video Conferencing

The next choice in meeting and conference room technology is whether you need audio conferencing, video conferencing, or both.

Video conferencing has taken center stage in the meeting room. Most platforms provide Outlook and Google integrations for easy meeting scheduling. Push to join is also becoming a more readily available option.

As video calls become more mainstream, organizations are on calls with clients, partners, and off-site employees. These external participants may be calling in from a different video conferencing platform. Fortunately, most video conferencing technologies can handle these situations offering easy dial in instructions for those working with different systems.

Scaling web conferencing is a big trend. Audio is the second piece of the meeting room communication. While some companies are comfortable going all-in with video calls, others still want the option for audio conferencing. It’s common for companies to have both audio and video conferencing technology in a single room, just let your AV partner know in the design process so they can include the functionality in your design.

### Microphones & Speakers

Microphones and speakers are an important addition to conference room audio visual. These can be either in-ceiling, on-table, or a sound bar mounted below the display (sound bars can be an appropriate solution for smaller spaces).

Based on how you intend to use the room and the features of the space, your audio visual integration partner can select the right mix of microphones and speakers.

The choice of microphones and speakers will have a significant impact on the overall conferencing experience. The right set-up can reduce echo, feedback and other noises heard by conference participants.

### Lighting Control System

Controlled lighting allows you to create the perfect setting. An integrated system, along with motorized shades and draperies, enables you to adjust the aesthetics to your liking. Instead of merely turning on / off various lights in the meeting room, the system can work together in any combination to offer preset sequences or prearranged schedules. You can program scenes for scenarios.

Almost no other area is used as diversely as meeting rooms, the spectrum ranging from prestigious customer meetings and multimedia presentations to creative get-togethers and brainstorming. Each situation demands different lighting conditions.

Intelligent lighting solutions enable light to be optimized according to aesthetic and functional factors, including lighting intensity, light colour and the flexible combination of direct and indirect light components.

Meeting rooms need careful attention because the range of activities spans from one-to-one talks via presentation to big conferences. At the same time, the interior and lighting design communicate the company culture internally and externally.

A flexible lighting scheme with efficient control systems supports the various uses of the meeting room. Ceiling luminaires provide efficient background lighting and lighting for more demanding tasks.

Spotlighting and wall washers light up details or walls and create variation. An easy to operate control panel should contain various light settings to support activities such as e.g. note-taking, presentations or conversations.

Dimmable (brightness changeable) lighting should be preferred in meeting and conference rooms. Thus, you can reduce the brightness of light while presentation. In this way, you can draw attention to speaker and you provide enough lighting for the participants to take notes. You can switch off all lights for video presentations, which will increase the visibility of the screen and attract attention.

A good presentation light is needed to see the presenter's face well. This light would need to be synchronized with screen-based presentations or videos.

Since there are many events in meeting rooms from face to face interviews by presentations to large conferences, it is very important to gather attention in this areas. On the other hand, the design and the lighting of this areas reflects the company culture to guests by different way.

### Automated Shades or Motorized Window Treatment

With motorized shading control solutions, you can easily raise the shades to add sunlight, or lower them to reduce heat buildup and add instant privacy. Shades can be preset to automatically open and close during a specific time a year, effectively controlling sunlight to decrease energy requirements. Or if you prefer, you can simply push a button to adjust them when you want, achieving the greatest beauty and efficiency in each room at all times. You can control glare and heat while increasing comfort for those attending meetings and presentations.

### Surveillance

If your room is staged for video calls it will need to be equipped with a camera. This can range from a small camera in a huddle room to something more sophisticated in larger spaces. Depending on your huddle room furniture configuration, you might consider a camera with a 180 degree viewing angle. You can also note that the nature of huddle rooms are small collaboration spaces. Therefore, the table and chairs are often pushed close to the display and camera. If the camera's viewing angle is too narrow then those sitting closest to the display will be left out of the field of view.

### The Importance of Modern Meeting Room Technology

Technology has been one of the biggest driving forces behind change in our society. It is evident when looking back throughout history and when looking ahead to the future. From the health field to the design world, and into people's everyday lives, evolving technology has made a huge impact: one way or another. It changes the way we learn, communicate, work, and play. There is less face-to-face interaction and more face-to-screen conversations today. Anyone who walks down a busy street and counts how many people are looking at their smartphones could attest to this.

This face-to-screen aspect has a significant impact on how we design spaces. We can notice a trend across all project types, particularly workplace and education. There is a want/need for specific technology to allow for some form of virtual meetings. Video conferences, instant messaging, screen sharing, and note transfers are just a few non-traditional meeting options technologies now brings to the table. Like anything else, there will always be advantages and disadvantages to these digital meetings:

#### Pros

- Saves time and money on travel. Between traveling costs, mileage, and possibly even hotels, a simple long-distance meeting can rack up big bucks and take hours. Technology allows businesses and schools to put that money toward something else on the list because they saved money on travel.
- Your geographical range can expand. It is a lot simpler to meet with someone across the world if you just tap in via video conferences. Even if there is a 12-hour time difference. One less reason to hold back on expansions for your business.

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- Everyone can feel connected. Whether it is connecting long-distance employees/clients to a project more directly or allowing a sick student to conference into class instead of missing a lesson, using technology has a way of bringing people together to make them feel included.
- Meetings can happen more frequently. Due to the costs of travelling, meetings would often be more sporadic and for longer periods. Now, you can hold a standing weekly hour-long meeting with individuals all around the world rather than traveling to one meeting every six.

#### Cons

- Can be hard to read the people on the other end. Not everyone is set up with capabilities to video conference in. This makes it impossible to read body language and make direct eye contact.
- It is expensive! It isn't a secret that high-tech comes with a high price tag.
- There can always be glitches that come along with technology. Jumping on an important conference call 20 minutes late because your conferencing system was having a technical problem can be frustrating.

In the past, there have been many design solutions to attempt to overcome these cons, and bring us back to the human interaction that started with that first meeting around a campfire. Several companies have developed possible solutions that were specifically designed to counter-act the inherent disconnect of looking at someone on a screen rather than physically sitting across the table from them. These "telepresence" rooms often try to recreate an in-person meeting room, through a variety of visual gimmicks such as curved tables or half of a table with a screen at the end, but these often fall flat. Furthermore, with fixed furniture, there is not much of an option to use this room for anything other than virtual meetings.

With the development of larger, thinner, and higher resolution display screens, we are approaching a time that has often been the subject of science fiction movies: wall surfaces become virtual displays, 360-degree virtual reality cameras recreating any location, holograms, etc. It does not seem like such a far-fetched idea now that you could have multiple people meeting in a "virtual" conference room, looking at the person on a screen as if they are sitting next to you. The flexibility of not being tied to a specific piece of furniture or specific set of technology frees the end user to use this room in a multiple of ways.

The biggest hurdle to this is going to be the cost and continuous development always spitting out the next "big thing". However, designing around an idea rather than a specific product could help alleviate some concerns, so new technology could be swapped into an existing room without a complete redesign. There is no perfect answer at this point to making the virtual meeting as effective as those first "meetings" around a campfire from the human perspective, but change is coming. And with each new development, we step incrementally closer to achieving that goal.

## CONCLUSION

History tells us that meeting locations tend to change, evolve. So do we. And the places we meet in are predominantly determined by that very fact. It can therefore be concluded that the future of meeting rooms doesn't lie in the design of the room itself, like where to fit the bean bag, pool table or VR helmet to ensure employee productivity and customer satisfaction, nor does it rely solely on high-tech communication or spontaneous trips to the local coffee shop – the future is in people and the way we organize ourselves. And meeting rooms are sure to follow.

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## THE IMPLEMENTATION OF MANUFACTURING AGENT'S CONCEPT FOR FLEXIBLE PRODUCTION SYSTEMS

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### ABSTRACT

The proposed report provides the analyzes of modern concepts of flexible integrated manufacturing systems (FIMS), that have essential effect for simulation and practical implementation of modern production control systems. There is considered the structure and functioning specifications of FIMS, of their control systems. As a improving tool there is overviewed the concept of intellectual manufacturing systems and multi-agent's approach to their implementation.

**Keywords:** decision-making, manufacturing agent, robotics, flexibility, integrated system.

### INTRODUCTION

The research, development and application of flexible integrated systems (FIS) is one of features of humanity entrance to the post-industrial stage of development. Application of FIS must provide the quick and low-cost transition to the new production types output, especially for conditions of low-series production. The efficiency of FIS is determined by optimal organization of technological equipment usage, supplied by robotized and transport systems, delivering bars, details and instruments, making the required service and check of technological processes.

The mass use of FIS becomes effective only then, if with the society demand for their application, the level and culture of production reach the certain quality level. Commercially viable development, introduction and exploitation of FIS's and robots are still quite expensive and not possible and every factory in any country. Recent Fukushima nuclear power station disaster, also earlier accident on oil platform in Mexico Gulf have shown, that even the most developed countries have level of robotics, which doesn't correspond the modern current needs of technical tools application in dangerous human conditions.

From the moment of Chernobyl disaster time in some aspects robotics haven't moved forward and the absence of required technical and informational supplement again lead to human resources using during quite simple tasks execution (investigation, transport operations, cleaning of territory with radioactive dirty) [1]. Therefore, the level of technical, technological and informational supplement of modern FIMS is in-corresponding to public challenges and asks for increased attention from theorists and practices. The mentioned makes researches in this field one of most perspective in modern science and technologies.

### The analysis of FIS Applications

Flexible integrated manufacturing systems (FIMS) are considered as the method of production organization, which supplies the total control of production process and assumes the incorporation of NPC-machines and other technological equipment by local computer network to unite the threads for details processing or assembling, application of cutting instruments, other supplement and corresponding information streams [3].

The analyzes of FIMS shows, that the robot's AI is mainly implemented by computer system, which controls the robot manipulator's movements or his mobile platform. The AI of robots is based on highly developed sensor system, which includes the technical vision systems of different types, sensors of tactile type, meters of distance, gyroscopes, compasses, sensors of color etc. In addition, apart from the recognition of scenes and tactile sensing speech recognition and natural speak processing have important role for FIMS intellectualization [5, 6].

The integrated automated manufacturing must include the in-built artificial intelligence tools, which supply the optimization of whole FIMS taking in account the overall cost of operations and resources. In this condition the manufacturing ACS have to supply the solving for the next problems: [6]:

- optimal application of instruments and equipment;

- minimization for details displacement and for billet storage level;
- minimization for machines and robots downtime;
- maximization for rate and output volume of production;
- minimization for production costs by materials and tools flows checkout;
- Computation of safe transition paths for systems of robots and interacting robocars with supplement.

The industrial robots need such AI-tools, which give possibility for self-education on base of collected data's on machines timeouts and declining of their characteristics, for response to emergency situations (tool breakage, outside objects appearance in workspace) and for required adaptation on manufacturing system functioning. Robot's, able for self-education and estimation of surrounding workspace can become the assistants of human in manufacturing sphere, which doesn't replaces him, but enriches by functions and simplifies the works with instruments, materials and informational flows.

The tendencies analyzes for FIMS development shows the rising complexity of modern manufacturing as for stand-alone work cell as for workshop or factory. For such conditions the role of automated control systems, which applies the AI-methods and are able with sensor systems to get information on state of manufacturing systems, to analyze it and to make decision on functioning of factory. From other hand, the part of manufacturing decisions at every workplace, which becomes the function of supplement equipment: robocars, industrial robots, and other technological and supplement systems?

Therefore, the problem of development and introduction of tools for intellectual decision-making support at different levels of manufacturing control and for particular units of FIMS is still actual.

Implementations of strategies' planning systems for robotics

The functionality of most of information systems (IS) has purposeful manner. The typical act of such functioning is a decision of planning task by need purpose achievement from fixed initial situation. The result of problem solving can be expressed as plan – the partially ordered sequence of actions. Such plan is similar to scenario, for which vertexes are connected by relations of type "purpose – sub-purpose", "purpose-action", "action-result" etc. Any way in such scenario, which leads from current state to one of vertex purposes defines the plan of actions [7].

The action's plan search task rises then informational system meet non-standard situation, for which there is no known action's set that reaches the purpose. All the tasks of action's plan construction can be divided into 2 typed, corresponding to different models: planning for space of states (SS-problem) and planning for space of tasks (PR-problem) [1].

For the first case the set of situations is given. Their descriptions include the states of surrounding world (workspace) and of Informational system (IS) with corresponding parameters. Situations are combined to generalized states and actions of IC or workspace changes lead to state's changes, actual for current moment of time. Among the generalized states – the initial (usually one) and final (purpose). SS-problem decision is in the search of path form initial state to one of the final.

For the space of tasks planning situation is slightly different. The workspace is created by introduction of relationships like «whole – part», «task – sub-task», «common – partial» etc. Therefore, the task space maps the decomposition of tasks to sub-tasks (purpose – to sub-purposes). PR-problem is in the search of initial task decomposition to sub-tasks, that leads to the tasks with available solutions.

Source [2] contains the classification of methods, used for solving SS- and PR-problems.

1. Planning on states. Presentation of tasks for the space of states includes the following descriptions: states, sets of operators, influences to transition between states and purpose states. States can be described by symbols, one- and two-dimensional arrays, trees, lists etc. Operators transform object form one state to other. Sometimes they have the production view:  $A \rightarrow B$ , meaning the transformation from state  $A$  to state  $B$ .

The space of states can be set by graph with vertexes of states, arcs of operators. If some arc is directed from vertex  $n_i$  to vertex  $n_j$ , then  $n_i$  is son, and  $n_j$  - father vertex. The sequence of vertexes  $n_{i1}, n_{i2}, \dots, n_{ik}$  for which every son vertex for vertex  $n_{ij-1}$  is a path  $k$  from vertex  $n_{i1}$  to vertex  $n_{ik}$ .

Therefore, the task to solve problem  $\langle A, B \rangle$  in planning be states can be presented as search task on graph from  $A$  to  $B$ .

2. Planning on tasks. Such method is effective for hierarchy structure of problem-solving. Planning search for tasks space is in the sequent reduction of initial task to more and simpler up to reaching the elementary tasks. The partially ordered set of such tasks combines the solution of initial task. The partition of task to alternative sets of subtasks can be easily presented as AND/OR graph. In such graph any vertex (apart from end) has conjunction (of type AND) and disjunction (of type OR) vertexes. For particular case, if AND-vertexes are absent, there is graph of state's space. The end vertexes are finite (corresponded to elementary tasks) or not effective (deadlocks). The initial vertex (the origin of graph AND/OR) is

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initial task. The purpose of search for graph AND/OR is to show, that the initial vertex has connection to solutions. The solutions are final vertexes (of type AND) for which all the son vertexes can be solved and all OR-vertexes with at least one solved son vertex. The example of implementation of planning method of General Problem Solver – GPS.

3. Planning with help of logical inference. It assumes the description of states as Well-Formed Formulas (WFF) for certain logical computation, operator's description as WFF or translation of WFF to others. The presentation of operators as WFF lets to create the deductive planning methods, the presentation of operators as translation rules – to create the planning methods with elements of deductive inference.

### Manufacturing agents and proposals on it's applications

For case of FIMS adaptivity is a possibility to keep manufacturing system workability for case of functioning condition changes, caused by external (other FIMS, transport system, energy supplement, ventilation system etc.) and internal (work of processing units, NPC-units, transport system, personal activity etc.) sources.

For such conditions FIMS must adapt to the current conditions and change the schedule (plan) for whole system functioning or for some parts, providing the adaptation of functioning strategy.

The technological process of mechanical processing and assembling must be provided in one or several workshops with processing centers, NPC-machines, industrial and transport robots, storages and the transport system, connecting the technological equipment and the automated storehouse.

The lacks of production process organization for the mentioned mechanical and assembling workshops are:

- the fixed mode of transport system work and insufficient level of automation with limited application of industrial robots;
- the manual loading for NPC-machines;
- the absence of automatized tools to avoid the emergency or non-standard production situations.

To overcome the mentioned lacks there are proposed:

- to introduce the mobile assembling-transport robot to the equipment of flexible integrated systems and workshops (Fig. 2.);
- to develop the mathematical and algorithmic supplement, the software for the mentioned robot.

The mobile assembling-transport robot must correspond to the following requirements:

- free movement in range of workshops out of technological equipment units workspace;
- robot supplies the delivery of billets and other materials to the workspace of processing centers and NPC-machines;
- robot supplies the delivery of needed instruments or equipment on regular or irregular calls;
- robot supplies the execution of selected assembling operations;
- robot supplies the monitoring for technological and other equipment of workshop;
- robot checks the functionality of technological equipment.

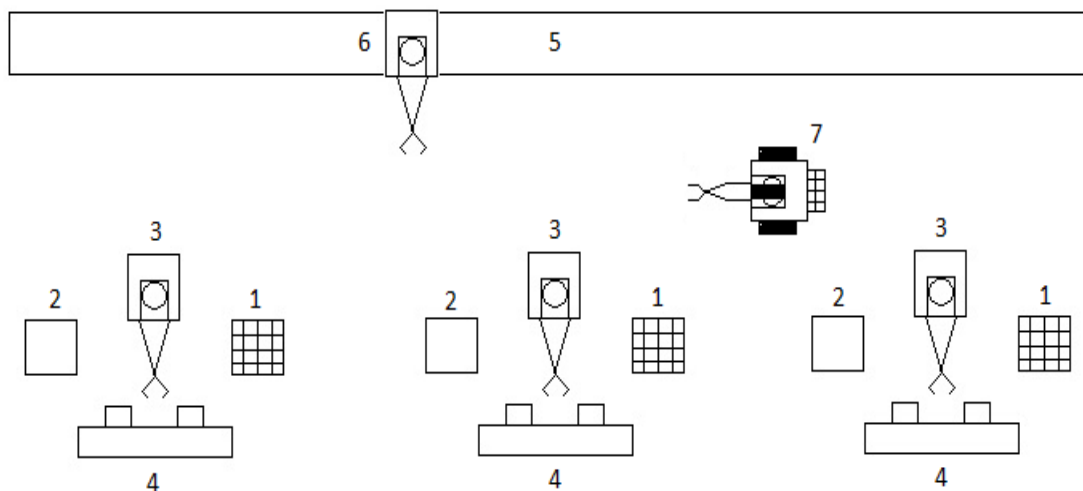


Figure 1 – The structure of flexible automated sector

(1, 2 – input and output storages, 3 – industrial robot, 4 – NPC-machine,

5 – transport system, 6 – transport robot, 7 – intellectual assembling-transport robot)

To supply its functionality the assembling-transport robot must correspond to the following construction demands:

- the presence of mobile platform chassis;
- the presence of manipulator (or of several manipulators);
- the presence of cargo block to transport billets, details, instruments and equipment;
- the presence of communication system;
- the presence of control system with computer on-board;
- the presence of sensor system for chassis and manipulator.

The assembling-transport robot must be selected on base of existing models of transport robots and manipulators.

The particular element of control system for mobile assembling-transport robot is decision-making support system (DMSS). As to dynamics of robot's workspace DMSS must supply the problem-solving for transition tasks of assembling-transport robot to particular workspaces, to schedule the loading-uploading operation for technological equipment, instruments and supplement, to plan some assembling operations. The dynamic nature of assembling-transport robot workspace, determined by particular production system, defined the demands of functioning strategies adaptivity, which must supply the increase stability and productivity of flexible manufacturing systems.

## CONCLUSION

The proposed work provides the analyzes of modern concepts of flexible integrated manufacturing systems (FIMS), that have essential effect for simulation and practical implementation of modern production control systems. In particular, there is considered the structure and functioning specifications of FIMS, of their control systems. As a improving tool there is overviewed the concept of intellectual manufacturing systems and multi-agent's approach to their implementation. As an example of manufacturing agent's concept practical implementation the functioning of industrial and transport robots is proposed. Robots, unlike the logical agents, are the real material objects of physical world and, actually, the physical agents. Because of that, robots are supplied by different execution tools of manipulation type, by sensor systems to measure the workspace parameters. Some robots are mobile and able to move on workspace. The real robots act in conditions when the workspace is only partially determined, stochastic, dynamic and continuous. For the most of real cases, the robot's workspace is multi-agent and sequential.

Therefore, the speed and quality of functioning strategies planning for FIMS is defined by selection of methods of data search for intellectual robotized system. The strategies planning correspond to the multi-stage decision-making models. The functioning strategies planning for FIMS can be described by a number of states and tasks with fuzzy and probabilistic methods application. During development of functioning strategies planning systems of FIMS the subject of essential attention is simulation of robot's and surrounding objects workspace. The systems of strategies planning can be practically implemented as action planning systems and correspond to the concept of manufacturing agent.

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## CYBERSECURITY ISSUES IN THE INTERNET OF THINGS

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### ABSTRACT

The article discusses the main problems associated with cybersecurity on the Internet of things, on the example of their implementation in the technology of "smart house". The advantages and disadvantages of modern data transmission technologies are considered. The shortcomings of data exchange protocols and the main directions for solving these problems are indicated.

**Keywords:** internet of things, smart house, data transmission technology, messaging protocols, cybersecurity.

### INTRODUCTION

Today, smart houses are one of the most promising areas in the field of Internet of Things (IoT), the prospects for this segment of the device market Zion Market Research estimates at \$ 53.45 billion by 2022 [1]. The development and application of artificial intelligence in commercial projects and the use of voice assistants Apple HomePod, Google Home and Amazon Echo are becoming more common.

Despite the rapid growth of the consumer market of smart devices from early adopters, the full-fledged success of this field depends on how quickly developers can solve the main problems and provide users with ready-made solutions:

- A more convenient interface (and compatibility of devices with each other).
- Affordable price.
- Data security.
- Convenient interface

Smart houses are a relatively new area in which there are no established usability or quality requirements.

With the increase in the number of smart house users, the industry is gathering more and more information to understand how you can improve customization and provide a more affordable out-of-the-box design. Although the creators of smart assistants (smart / voice / home assistants) are not directly involved in device development, they can affect many decisions by creating UX / CX standards, a list of technical requirements (latency, performance, interaction protocols) [2].

### Problems review

One of the main problems of implementing a smart house from a security point of view is the choice of data transmission technology. There are several basic data transfer technologies: Z-Wave / Zigbee / Bluetooth / Wi-Fi.

Zigbee became standardized in 2003, developers claim compatibility with other brands, products, manufacturers and the Zigbee version. The advantages include: interaction - most other Zigbee products will work with each other; scale - a large selection of products, which includes many Powerhouse brands, such as Philips, Lutron, Samsung, etc. ; the price – it is not expensive, given that their technology is not proprietary (thus, it does not control the premium price); range - all devices that are always on act as a repeater. The main disadvantage is the interaction of most brands work with each other, but because of the many, many manufacturers who produce real Zigbee radio, it is difficult to know which ones meet the standards of alliances.

Z-Wave technology was adopted in the United States in 2001, in 2005 a group of manufacturers came together to form the Z-Wave Alliance, regardless of manufacturer, brand, product, year of product creation or version of Z-Wave software, all Z-Wave products will interact with each other. The advantages of Z-Wave include: interaction - the selected Z-Wave product must be certified; scale - Z-Wave works with more than 1500 products; no interference with Wifi bands, Z-wave operates on a separate radio frequency wave; range - can grow depending on the number of devices that are on the network. Cons of Z-Wave: the price may be much more than WiFi, but there are no special advantages; moving to another

1st International Scientific-Practical Conference:

Modern Information, Measurement and Control Systems: Problems and Perspectives (MIMCS 2019)



country - Z-Wave devices are programmed with the radio frequency of their intended countries, if you go to a country that does not support the frequency the device is programmed for, it will not work.

Bluetooth and Bluetooth Low Energy (LE) was launched in 1994 by Ericsson and is now managed by the Bluetooth Special Interest Group. Bluetooth Low Energy (BLE) was developed in 2011. Pluses of Bluetooth LE: power consumption - long battery life; price - Bluetooth has been around for a long time and is a standard recognized by many, it should be able to offer quality products at a lower price; compatible and centralized hub - no need for a dedicated HUB, since devices can directly connect to the home router. The disadvantages include: potential problems with interference - Bluetooth operates at 2.4 GHz, it is also susceptible to interference; the scale - it has recently entered the Home Automation industry and, therefore, does not have so many options available to the consumer, in addition, many HUBs do not support Bluetooth LE at this time; range - limited by the general range, physical obstacles.

WiFi for home automation has a number of advantages: the price is the ability to get a lot of offers on smartphones with WiFi support; scale - there are many offers of smart devices with WiFi support. The problems can be attributed to - problems with interference WiFi works at 2.4 GHz, as well as susceptible to interference. Energy intensity - Smart house battery products consume a lot of power.

The problem of affordable prices.

Many households will be prepared to automate trivial household tasks if the price of the final product is available in accordance with the purchasing power of households. Most consumers choose lamps at the initial stage due to the simplicity of the settings and the user-friendly interface, then they add a thermostat to control the temperature or a smart camera. If there is a desire to improve the setting and add a voice assistant and a monitor, the price tag can vary from \$ 50 to \$ 480. Therefore, manufacturers' priority is to solve the problem of accessibility of a smart house for more people [3].

The problem of data security.

With the advent of smart devices, hackers can hack data from devices, both in the cloud and on a physical device. Therefore, the problem of data security and confidentiality remains fundamental in the field of technology.

The "Security Analysis of Emerging Smart house Applications" study breaks vulnerabilities into 2 categories:

1) excessive privileges;

2) insecure messaging.

Excessive privileges are a security breach when a mobile application gains access / rights to operations that it does not really need for a work. When malware (malware) gain unrestricted access to SMS APIs or logs, it can lead to leakage of personal information (PII), including PIN codes or passwords.

One of the main methods of preventing such scenarios is coding, aggregation and anonymization of data [4].

By working together, device manufacturers, the mobile application certification center and the users themselves can reduce the risk of data being discredited. One of the main factors of competition between manufacturers is the security of user data - starting from the design stage and the system design of the product, apply the latest data protection solutions to thorough testing for potential security problems. One weak link will be enough to discredit user privacy [1].

### **The problem of unprotected messaging.**

IoT devices use different communication and messaging protocols at different levels. When developing an IoT device, the choice of protocol depends largely on the type, level and function that the device must perform. MQTT, XMPP, DDS, AMQP and CoAP are several widely used communication protocols for the IoT application layer.

MQTT is a machine-to-machine (M2M) protocol. This is a publish and subscribe based messaging protocol used to transfer device data to servers. The main purpose of the MQTT is the remote control of IoT devices. It is mainly used when it is necessary to monitor or manage a huge network of small devices via the Internet, that is, parking sensors, underwater lines, the power grid, etc.

XMPP (Extensible Messaging and Presence Protocol) was originally developed as a messaging protocol known as Jabber. It uses XML format for messaging. The main feature of this protocol is its addressing mechanism. It identifies devices / nodes in an IoT network using an address known as Jabber ID (JID). JID follows the standard - name@domain.com. This addressing mechanism allows two nodes to exchange information no matter how far the nodes are on the network.

XMPP messages are usually transmitted over a basic TCP connection. It uses the polling mechanism to determine the destination of the message. XMPP is implemented using a client-server architecture. The client starts the XML stream by sending the opening <stream> tag. The server then responds with an XML stream back to the client. Because XMPP is an open protocol, anyone can have their own XMPP server on their network without the need for an Internet connection.

DDS is also based on the publish-subscription model. DDS connects devices directly, unlike MQTT, which connects them to the server. This is why DDS is faster than MQTT. Apparently, it can deliver millions of messages to several different recipients in a matter of seconds, since it eliminates communication with the server. DDS can be used to provide communication between devices over the data bus. This ensures detailed service quality and reliability.

Enhanced Message Queuing Protocol (AMQP) is an application-level, open layer protocol for sending transactional

messages between servers. As a message-oriented middleware, it can process thousands of trusted transactions in a queue. AMQP is designed not to lose messages, since messages can be transmitted using TCP or UDP. Using TCP provides a reliable point-to-point connection. In addition, endpoints must acknowledge the acceptance of each message. The standard also describes an additional transaction mode with a formal multi-phase commit sequence. Based on its origins in the banking industry, AMQP focuses on tracking messages and ensuring that every message is delivered to its destination, regardless of failures or reloads.

All of the above protocols are uniquely applicable to different working scenarios. Any protocol can be selected manually based on their pros and cons for developing IoT applications. The main factors to consider when choosing any of them for application is the quality of service, security and reliability required for your application [5].

Japan's Trend Micro Cybersecurity Firm has published a report on the security status of IoT. The company found that two of the leading machine-to-machine protocol (M2M) have internal design problems and are often deployed in an insecure manner.

According to Trend Micro's "Fragility of Industrial IoT Data Trunk" report, problems are related to two popular M2M protocols (MQTT) and (CoAP) with a simple keyword search, attackers were able to detect unprotected IoT servers and intermediaries.

## CONCLUSION

These protocols have not been designed with security in mind, but are found in an ever wider range of critical environments and use cases. This represents a serious cybersecurity risk. Hackers with even modest resources can exploit these design flaws and vulnerabilities for reconnaissance, lateral movement, hidden data theft, and "denial of service" attacks [6]. To overcome these and other current problems, many companies are looking for specialists with knowledge of Firmware (on the device), Software (on the cloud side). However, the availability of such specialists in the market is significantly limited. This leads to an excessive increase in the cost of their work. Thus, the search for universal solutions in the field of security of the Internet of Things is one of the most pressing problems at the present stage of cyber technologies development.

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## INNOVATIVE MECHANISMS FOR THE DEVELOPMENT OF A MARKET FOR ENVIRONMENTAL GOODS AND SERVICES

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### ABSTRACT

The article is devoted to the main trends and mechanisms of green market development. The main challenges of greening regional and federal markets of goods and services are considered. The contribution of innovative development to the solution of environmental problems is revealed.

**Keywords:** green economy, green markets, markets for environmental goods and services, green technologies

Currently, the market development for environmental goods and services is being comprehensively researched by representatives of various sciences, such as economics, law, geography and regional economy, sociology, etc. Scientific interest in innovative mechanisms, as well as in opportunities to transform Russian economy under the influence of global trends in environmental management has increased after the Russian Federation has adopted the BRICs Declaration on compliance with green economy and as the UN General Assembly's "2030 Agenda for Sustainable Development" with its 17 goals, including "Industry, Innovation, and Infrastructure" and "Responsible consumption and production" as well.

Environmental development of the Russian Federation involves environmental protection and innovative development; is based on the RF Constitution together with principles and rules of international law, international treaties of the Russian Federation, federal constitutional laws, federal laws, laws of subjects of the Russian Federation, and documents of long-term strategic planning.

These documents include The national security strategy of the Russian Federation up to 2020 [1], the Concept of long-term socio-economic development of Russia up to 2020 [2], the Foreign Policy Concept of the Russian Federation [3], the Strategy of the Arctic zone of the Russian Federation development and national security system for the period up to 2020 [4], the Water Strategy of the Russian Federation for the period up to 2020 [5], the Strategy of sustainable development of rural areas of the Russian Federation for the period up to 2030. [6], the Strategy of hunting sector development of the Russian Federation for the period up to 2030 [7], the Transport Strategy of the Russian Federation, the Strategy of tourism development of the Russian Federation for the period up to 2020, the Strategy for the conservation of rare and endangered species of animals, plants and fungi in the Russian Federation for the period up to 2030, The Strategy of Development of Insurance Activity in the Russian Federation up to 2020, the Strategy of innovative development of the Russian Federation for the period up to 2020, the Strategy of social and economic development of federal districts.

The Concept of long-term socio-economic development of Russia up to 2020 defines the purpose of environmental policy, which is to significantly improve quality of natural environment and eco-conditions of human life, to create a balanced environmentally-oriented model of economic development and environmentally competitive industries. To successfully implement the programme of ecological development is the most important contribution of Russia to global biosphere preservation and maintenance of the global environmental equilibrium. The Concept sets out the main directions of environmental protection.

- Production ecology (gradual reduction of environmental impact of anthropogenic sources). The main elements of this trend should be a new system regulating permissible impact on the environment to reject individual permits for each enterprise and establish standards and plans for gradual pollution reduction to levels corresponding to the best environmentally safe world technologies; to develop waste management industry, and to expand renewable energy sources. Introducing new technologies should be facilitated by tax policy measures, according to which environmentally friendly and energy-saving technologies will be provided with appropriate benefits for corporate income tax, land tax, property tax, as well as various deductions for personal income taxes. Thus, economic incentives will be created to upgrade production and appropriate technologies used by citizens. This is to reduce specific environmental impact by three to seven times depending on the industry.

- Human ecology (creation of a sustainable and comfortable environment for population to live, work and rest). This

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direction includes eliminating accumulated pollution, restoring eroded, cluttered areas, ensuring effective sanitation, managing household waste, promoting healthy lifestyles. It is necessary to develop special sustainable health and safety standards for human environment in order to carry out specialized monitoring. To implement this direction by 2020 means to reduce the number of cities with high and very high pollution levels by five times at least; to reduce the number of residents living in adverse environmental conditions by four times at least.

- Ecological business (creation of an effective environmental economy). This sector can include a competitive business in the field of general and special engineering, environmental consulting. Here, the government is to set rules of environmental audit, requirements for process development. In addition, it provides conditions for large-scale implementation of environmental management and increases the transparency of industrial enterprises in terms of their environmental impact and measures taken to reduce the negative impact. Besides, the state is responsible for monitoring the dynamics of environmental economic performance.

The target progress indicators in this direction are the market growth of environmental development, goods and services by five times and the expansion of employment from 30,000 to 300,000 jobs.

- Natural environment ecology (natural environment preservation and protection). This direction should be targeted at regional differences reduction among specially protected natural areas, a more effective and safer bio-productivity of natural systems, and species diversity restoration. Ensuring environmental efficiency of the economy is not only specific for business and economic policy, but also conceptual for innovative economic development, closely related to improving resource consumption efficiency. An increase in technological and environmental efficiency of the economy by 2020 is expected to result in reducing environmental impact by 2 - 2.5 times, which will allow to reach current figures of nature conservation in developed European countries.

Another essential document determining long-term trends and expected results of social and economic development in the Russian Federation and its subjects is the Forecast of long-term social and economic development of the Russian Federation for the period up to 2030. According to Section 8 "Environmental Protection. Economic development of resource potential" there are indicators of the RF environmental development providing for certain achievements in the following areas: emissions from stationary sources for different pollutants, cities with high and very high levels of air pollution, wastes of all hazard classes, fixed capital expenditures aimed at environmental protection and rational use of natural resources, and greenhouse gas emissions.

There is no consensus in the modern economic literature on the term "environmental service". However, the closest meaning reflecting the essence of environmental services as services of a special kind has the following definition: environmental services are activities carried out by various organizations (institutions) on a commercial, contractual or gratuitous basis to implement environmental compliance for third-party facilities.

In foreign businesses, environmental activities and services (market for ecological services) include the following:

- enterprises engaged in biodiversity conservation;
- pollution prevention enterprises (producing equipment, tools and control means for environmental protection, etc.);
- enterprises with nature-saving technologies (waste processing, producing goods with eco-labelling);
- enterprises engaged in landscaping;
- enterprises engaged in the information eco-business [8].

Worldwide, various ways of stimulating environmental technologies are used. They are environmental regulations, rules, legislation, subsidies to reduce emissions, tax incentives, and pollution rights. Experience has shown that direct control measures are the least effective way to stimulate.

In addition, a number of national scientific and technological programmes are being greened. Japan, Germany, Holland, Italy, Canada, France, Great Britain, and Norway are developing national schemes focused on ecologically important technologies. For example, in Japan, The Research Institute of Innovative Technology for the Earth (RITE) funded by the public and private sector was established in 1990. Its main activities are related to global warming and alternative energy sources. In Germany, a Program of Environmental Technology was developed by the Ministry of Research and Technology. In the Netherlands, the Technology Transfer Organization (TNO) is the largest Research & Technology Organization (RTO), in which environmental technologies amounts to 10 per cent of its activities. In Italy, the Fund for Technological Innovation (FTI) has been established, 5 per cent of which are used for developing eco-technology. Canada has introduced the Technology for Environmental Solutions Initiative (TESI). In many countries, environmental technologies are integrated into existing science and technology programmes and initiatives.

In developed countries, environmental engineering and technology is one of the most profitable industries causing the environmental market to boom. In the mid-1990s, over 40 per cent of the global market for environmental products and services were held by the United States [14]. American enterprises produce cleaning equipment and environmentally friendly consumer goods, such as organic foods, harmless paints, etc. Manufacturing such products is considered to be prestigious and profitable, and enterprises thereby create their own advertising and a favorable market recognition. Environmental product settings affect the enterprise's competitiveness in the global market.



Due to enhancement of environmental legislation in almost all countries, there will be an increase in environmental engineering and technology industry. This process has already begun throughout the Western world.

The development of the market for eco-innovations is significantly influenced by the EU directives, in particular, requirements to the content of sulfur dioxide, nitrogen oxides and dust in the flue gases emitted by thermal power plants. They make manufacturers develop devices for monitoring trace pollutants. Western European companies engaged in environmental business are successfully using current trends in environmental policy to increase their profits.

While in the 1970s and 1980s, companies mainly strove to neutralize possible consequences of environmental damage, in the 1990s, the emphasis was placed on eliminating causes of environmental violations. Taking preventive measures, rather than neutralizing the pollution effects, is considered by experts a more reliable means of addressing environmental problems.

It is possible to note the main alternatives in the ecological market:

1) Improving existing products by adapting them to new environmental requirements. Many operating companies are expanding their business by fitting manufactured goods or production methods to new market needs. In the 1990-ies, it was popular for companies to review the environmental impact of their products throughout their entire lifecycle, from their production to disposal after disuse ("from cradle to grave" approach).

2) Designing fundamentally new products and even setting up specialized companies for this purpose. The need to address environmental problems and fierce market competition offer exciting possibilities for development, production and marketing of entirely new products instead of environmentally hazardous ones. At the same time, sustainable development gives the best prospects for companies. In some cases, enterprises create new products from waste materials.

3) Investing foreign funds. In some cases, a rapid market development for environmental goods and services leads to companies unwilling to launch new products that may become obsolete before their distribution starts generating a profit. To reduce the risk, companies are trying to attract foreign investors, especially from countries with a developed market for environmental goods and services. Apart from risk sharing, foreign direct investments offer opportunities to acquire new technologies and expand marketing outlets.

4) Providing environmental services as information, consulting, or expert assistance to solve environmental problems, to provide training for environmental specialists, etc. Some other new service areas include technical advice, environmental assessment and audit, waste and recycling management, transportation, retailing, green advertising and marketing.

Certain challenges of market development for environmental services are the following:

- global environmental crisis caused by industrial production development and an increased anthropogenic impact on the biosphere;

- current contradictions (often very sharp) between global and local benefits [9].

Innovative development has greatly contributed to coping with environmental challenges. Thus, technological production upgrade has created respective technical and other conditions for greening industries. Areas affecting environment, both directly and indirectly, can be divided into:

1) technological innovations leading to an increase in production efficiency, expansion of the product range and higher quality of manufactured goods and services or applied techniques, a succession of equipment models and generations, technological structures and processes aimed at linking economic development with the requirements of environmental protection;

2) resource economy (as a key type of technological innovations) associated with introducing resource-saving technologies that not only reduce the extraction extent of various types of natural resources, but also ensure a more complete and integrated usage. Consequently, this can ease the environmental burden from mining and processing industries [10];

3) environmental innovations;

4) tools needed for ecological and innovative activity, incentives for development of ecological services market, eco-production and technologies, etc.;

5) innovative management, legal and other solutions to improve the efficiency of natural resources utilization, along with enhancement or at least maintenance of natural environmental quality;

6) long-term development of the market for environmental pollution rights based on practices in other countries that have enforced such mechanisms within environmental management, as well as on international experience in this area (in particular, the economic mechanisms under the Kyoto Protocol). This will enable to subsequently transfer know-hows to the national level.

To sum up, currently, environmental services market has great prospects for future development. Thus, along with the main types of environmental services (environmental audit, environmental insurance, environmental management and waste disposal), there appear other activities, such as emission trading. The latter direction is a completely new international market, where product demand is more than significant.

The article has been prepared for publication under the sponsorship of the Russian Foundation for Basic Research,

project No. 19-010-00194 A

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## INITIAL RESEARCH OF MINERAL BASED ANTI-CORROSION MULTICOMPONENT COMPOSITE MATERIAL

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### ABSTRACT

The new approach is to create a multicomponent composite material on a basis of mineral component by defining extreme value of the multi-variable function. It is decided to carry out theoretical analyze first. For theoretical analysis, the effects of component quantity on the parameters to be determined by experiments and in all cases the results to be theorized. Thus, the mathematical formula for the relation of anti-corrosion with components has been determined. In order to evaluate anti-corrosion it is defined multi-variable functional relation and with this function it is achieved extreme values on optimum values of each component. The new material is compared to traditional anti –corrosion material that are common. Currently implemented anti –corrosion material doesn't require needs of modern technological expectation. From this point of view anti-corrosion materials need to have appropriate technical parameters. Traditional anti-corrosion materials basically have one or two components and these materials has protective film layer. Disadvantage of this film layer is whole layer can easily be destructed from weak point. This is due to the fact that traditional materials form film layer in connection areas. Compare with this one the new material has discrete structure. On this basis, the combination of protective and constructive material binding based on adhesion and cohesion. The structure not allows material to be destructed from weak point.

On a basis of achieved theoretical results optimal quantity of each component is clarified, anti-corrosion material is made and tested. The novelty of the approach is to achieve high quality anti-corrosion material by defining an extreme value of the multi-variable function.

**Keywords:** high quality anti-corrosion material, multi-variable function, protective and constructive material binding.

### INTRODUCTION

Implementation of high-performance materials is the important issues in the high development era of economics and technology. Generally one of the factors that cause corrosion processes to be raised as a major problem is corrosion caused by atmospheric effects. Therefore, atmospheric corrosion remains a major research object for professionals working in this field. Due to the effects of atmospheric corrosion various industrial equipment to be destructed, huge amount of pollution to be released to the environment and this cause environment which is affected by negative anthropogenic activity to be polluted more. As known, there are traditional methods to improve the resistance of steel against to corrosion, which is based on using of anti-corrosion inhibitors that are most effective and easy to use. One of the widely used applications of corrosion inhibitors is the oil production and refining industries. High results were achieved by using corrosion inhibitors in this area.

Another method is to apply paints. Paints are complex formulations of polymeric binders with additives which include anti-corrosion pigments, colors, plasticize, ultraviolet absorbers, flame-retardant chemicals, etc. Almost all binders are organic materials. Specific formulations are available for application to aluminum and for galvanized steel substrates. Paints are not normally used to protect plant intervals exposed to anything other than water due to their generally poor resistance to solvents, acids, alkalis and other corrosive agents. Even clean (i.e. potable or better) water is damaging to most epoxy-based coatings (*Michael J Schofield, 2002*).

Nano technology can be used to create a "self-healing anti corrosion material". Traditionally chromium-based compounds and zincs were the go to coating materials. However, modern HSSE practices and price fluctuations have significantly contributed to this decline. Corrosion protectors that are chromate based are unfortunately environmentally unfriendly due to their leachability on the coating surface. Self-healing anti organic anti corrosion coatings can be useful for long term protection of structures, because they perform self-recovery of the initial properties of the material after damage from the surrounding environment (*Mittal 2014*).

It is always developed and implemented simple and practical methods to protect common used steel constructions. Currently, in the technique is widely used two component composite materials. One of these components is adhesive, other is filler which commonly consist of synthetics fibers. The functions of these components are very different from one another, so these materials should be regarded as a primary variable composite. For this purpose, the creation and

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development of multi-component composite materials is of great importance.

We have achieved to create Adelin-K1 multicomponent composite material to prevent corrosion of steel construction in caspian sea environment by determining extremum of multivariable function. It was observed corrosion process on this material in the sea-water environment at specific points and lines which are consisted of these points. One of the major problems in the corrosion of steel structures is the determination of the corrosion starting areas. We have found that the starting point of corrosion is not the obstruct areas, they are specific points and lines. These points and lines depend on the geometrical form of the structure. In our view, this is the corrosion concentration points. Corrosion in these places stimulates the formation and development of the next chemical and electrochemical corrosion. The origin of this corrosion is related to mechanical processes. As a result of the theoretical analysis the probability of corrosion is determined to infinity in the aforementioned points. That's why probability of corrosion is accepted corrosion concentration starting time.

### Experimental and theoretical analysis.

In order to create multi-component composite material, first of all it is necessary to create theoretical basis. In our opinion, the use of multivariate complex functions for this purpose is a correct way. It is known that ordinary functional dependency is used for a variable composite material. The extreme value of such a function is derived from the first derivative. In some cases, the proportion of components can be about 300-400 when creating multi-component composite material. Finding extremum quantities by modeling is very complicated. The extremum value in the multivariable function is determined by the help of special differentials. This allow any ratio of the component to be considered. In order to compensate for the extreme value of the desired parameter of the multivariable complex function, the second differential of the complex function, ie quadratic form, is assigned.

. In order to define extreme value of the desired parameter of multivariable complex function it is defined the second differential of the complex function, i.e., it's quadratic form.

$PS = F(x, y, z, \dots)$  It is defined second differential of PS function, PS- parameter to be searched

$$\begin{aligned} d^2(PS) &= d^2F(x, y, z, \dots) \\ &= \frac{\partial^2 F(x, y, z, \dots)}{\partial x^2} dx^2 + \frac{\partial^2 F(x, y, z, \dots)}{\partial y^2} dy^2 + \frac{\partial^2 F(x, y, z, \dots)}{\partial z^2} dz^2 + \dots + 2 \frac{\partial^2 F(x, y, z, \dots)}{\partial x \partial y} dx dy \\ &\quad + 2 \frac{\partial^2 F(x, y, z, \dots)}{\partial x \partial z} dx dz + 2 \frac{\partial^2 F(x, y, z, \dots)}{\partial y \partial z} dy dz \dots \end{aligned}$$

If  $d^2(PS) = d^2F(x, y, z, \dots)$  does not change the sign of a certain limit, then there is an extremum

If  $d^2(PS) < 0$  maximum

If  $d^2(PS) > 0$  minimum

If  $d^2F(x, y, z, \dots)$  change the sign, then there is no extremum. It means that the component does not have a positive effect on the quality of the multicomponent composite material. The most difficult issue is to determine the sign of  $F(x, y, z, \dots)$ . For this purpose the matrix of  $d^2F(x, y, z, \dots)$  to be determined.

$$A = \begin{pmatrix} \frac{\partial^2 F(x, y, z, \dots)}{\partial x^2} & \frac{\partial^2 F(x, y, z, \dots)}{\partial x \partial y} & \frac{\partial^2 F(x, y, z, \dots)}{\partial x \partial z} \\ \frac{\partial^2 F(x, y, z, \dots)}{\partial y \partial x} & \frac{\partial^2 F(x, y, z, \dots)}{\partial y^2} & \frac{\partial^2 F(x, y, z, \dots)}{\partial y \partial z} \\ \frac{\partial^2 F(x, y, z, \dots)}{\partial z \partial x} & \frac{\partial^2 F(x, y, z, \dots)}{\partial z \partial y} & \frac{\partial^2 F(x, y, z, \dots)}{\partial z^2} \end{pmatrix}$$

As per *Sylvester's criterion* it is determined the sign of the matrix.

If the main **minor** of the **matrix** are **positive** then PS is positive,

$$A_1 = \frac{\partial^2 F(x, y, z, \dots)}{\partial x^2} > 0$$

$$A_2 = \begin{vmatrix} \frac{\partial^2 F(x,y,z,...)}{\partial x^2} & \frac{\partial^2 F(x,y,z,...)}{\partial x \partial y} & \dots & \dots & \dots \\ \frac{\partial^2 F(x,y,z,...)}{\partial y \partial x} & \frac{\partial^2 F(x,y,z,...)}{\partial y^2} & \dots & \dots & \dots \\ \vdots & \vdots & \ddots & \ddots & \ddots \end{vmatrix} > 0$$

$$A_3 = \begin{vmatrix} \frac{\partial^2 F(x,y,z,...)}{\partial x^2} & \frac{\partial^2 F(x,y,z,...)}{\partial x \partial y} & \frac{\partial^2 F(x,y,z,...)}{\partial x \partial z} \\ \frac{\partial^2 F(x,y,z,...)}{\partial y^2 \partial x^2} & \frac{\partial^2 F(x,y,z,...)}{\partial y^2} & \frac{\partial^2 F(x,y,z,...)}{\partial y^2 \partial z^2} \\ \frac{\partial^2 F(x,y,z,...)}{\partial z^2 \partial x} & \frac{\partial^2 F(x,y,z,...)}{\partial z^2 \partial y} & \frac{\partial^2 F(x,y,z,...)}{\partial z^2} \end{vmatrix} > 0$$

If pair main minors are positive or single minors are negative, then the quadratic form of searched parameters are negative.

$$A_1 < 0, A_2 < 0, A_3 > 0$$

On this basis, we have been able to create composite materials that have specific features for more than 20 years. Waterproof and moisture-resistant multi-component composite material is successfully applied to the facades of major buildings in Baku, including the offshore over 15/20 years (**Figure 1, Figure 2**).



Figure 1.



Figure 2.

It should be highlighted that this composite material is adhesive to almost all materials (metal, concrete, polystyrene, plaster).

In our opinion, the use of multiple glues in creation of universal multi-component composite material produce very serious results. In this case, both organic and inorganic materials should be used.

In optimal values of multi - component composite materials it is needed to get the extreme outcome of their desired parameter.

As a result of the research, we have found methods to prevent the initial starting of corrosion. The principal problem of creating corrosion-resistant material is concentration to be formed on separate points and their generated lines. That's why initially we accept geometrical shape as a criterion of corrosion starting (**Figure 3, Figure 4, Figure 5**, points are in red cycle).



Figure 3

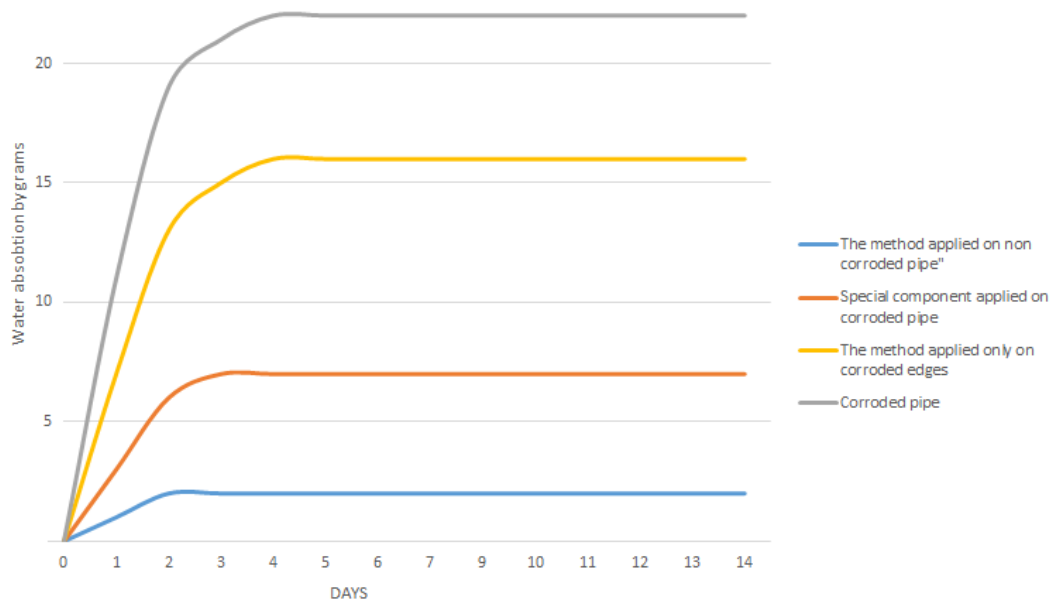


Figure 4



Figure 5

By this way it has been determined the ways of destroying of concentration. In the next stage, as a criterion we have determined the amount of seawater absorbing by Adelin-K1 multi-component composite material on the sample. In numerous trials (graph. 1) only 0.2 percent of sea water surface falls were observed only in the first and second days. In numerous tests (graph. 1) only 0.2 percent of sea water surface absorption were observed only in the first and second days.



Graphic 1.

In the following days despite all samples were sunk in the Caspian sea water there was no absorption. It means relation takes asymptotic form. After taking samples from sea water during 15-20 minutes low percentage surface absorption disappeared. The sample returns to its previous. This shows that our protective layer does not accept water. There is no hygroscopic water in our protection layer. Low water is a free water. At this stage no defect has been observed (**Figure 6**, **Figure 7**).



Figure 6



Figure 7

## CONCLUSIONS

It is created multi-component composite material by defining extremum of multivariable function. As per the principle to define extremum of multivariable function it has been established that it is possible to create multi-component composite material which resistant to the aggressive impact of Caspian Sea water. The analysis of the proposed theoretical and experimental results can allow us to create multicomponent composite

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material which can be applied direct in sea water.

With the help of special types of the multi-component composite material which are created based on the proposed methods, it is possible to restore cross-section dimension of weaken steel structures. It means this can provide previous load capacity.

The analysis of theoretical and experimental results allows us to improve the theoretical model. Finding the extremum of this multi-variable function allows us to achieve multi-component material. However, the difference between the theoretical and experimental results relatively large (25-30%). This differences show us that the theoretical model needs to be improved.

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## ENSURE PREPARATION AND SUBMISSION OF FINANCIAL REPORTING WITH INNOVATIVE TECHNOLOGIES

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### ABSTRACT

„Association Agreement between on the one hand Georgia and on the other hand the European Union and the European Atomic Energy Union and their Member States", which entered into force on July 1, 2016, became the basis for the implementation of reforms on accounting and submission of financial statements in Georgia.

The financial reporting reflecting the financial condition of the financial and financial activity carried out by the enterprise during the reporting period allows its management and a wide range of users to make an economic decision after adequate analysis, as its indicators include assets, liabilities and It provides full information about the capital of the capital, as well as its expenses and earnings. Financial Reporting users have different interests and requirements.

Many enterprises of the world submit financial reports to external customers. Although the financial statements of different countries are similar, among them there are some differences that are caused by many social, economic and legislative factors, as well as the creation of national accounting standards in these countries taking into consideration.

At present, Georgia has a financial statement preparation and presentation of the four categories of standards: International Financial Reporting Standards (IFRS), International Financial Reporting Standard for Small and Medium – sized Enterprises (IFRS for SMEs), the fourth category of enterprises established financial reporting standards and (non-profit) uridiuli entities established financial reporting standards.

The above standards are governed by the appropriate size of enterprises, which are classified by the Law of Georgia on Accounting, reporting and Audit (2016). According to the same law, the level of enterprises of the enterprises were based on the relevant criteria. Namely: the total value of assets, the Income and the average annual number of employees.

**Keywords:** Business, Enterprise Categories, Financial Statements, Standards, Legislation.

### INTRODUCTION

Financial Reporting is a structuredly formulated financial image of the financial position of the enterprise and its operations carried out during the reporting period. The financial statement reflects information about the company's assets, liabilities, own capital, revenue and expenses, profit and loss, cash flow of the enterprise, as well as accounting policies and other additional indicators. The information provided allows its users to make economic decisions. Consequently, the goal of the financial statements is to provide information about the financial position of the enterprise and its changes, the results of the enterprise's activities and the cash flow, which will be useful for economic decisions and improvement of corporate governance.

In order to improve the financial transparency and financing of financial subjects, the law enacted in Georgia in 2016: "Accounting, Reporting and Audit", according to which the division of enterprises was divided. The size of the enterprise is determined by the three criteria, the total value of the assets, the income and the average number of employees. The division of the categories is the basis for which the financial entity must prepare to submit the financial statements.

The purpose of presenting financial statements is to provide information on existing and potential investors, accountable to the creditors and other creditors, which will be useful for them to make decisions on providing the enterprise with resources.

### Body part

Economic integration of Georgia puts the country in compliance with certain requirements and obligations between Europe and its member states. One of these requirements and obligations includes issues related to accounting, reporting and auditing in Georgia. Performing certain reforms in Accounting, Accounting and Audit in the field of accounting-reporting major challenges, improvement of business environment, global situation and tendencies. The reform is envisaged by the EU-Georgia Association Agenda, EU Directives and Georgia-EU Deep and Comprehensive Free Trade Agreement (DCFTA). On June 27, 2014, the Agreement on Association Agreement on the one hand, between the EU and the

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European Union and the Atomic Energy Union and their Member States, was signed on July 1, 2016. This agreement became the basis for some sort of regulation of accounting and financial reporting in Georgia.

On the basis of this Agreement, the Parties agree to cooperate in the following areas:

- (a) Protection of shareholders, creditors and other business partners in accordance with the EU rules in this field;
- (b) Implementation of relevant international standards at national level and gradual approximation with EU rules in accounting and auditing;
- (c) Further development of corporate governance policy in compliance with international standards and gradual approximation with EU regulations and recommendations in this area. [Chapter 6. Article 316].

With the help of foreign donors in Georgia, various activities of supporting reforms in Accounting, Reporting and Audit are carried out. From this point of view, the law adopted by the Parliament on "Accounting, Reporting and Audit" and "Accounting and Supervision Supervision Service" created by the Government of Georgia is a state policy and is a legal entity under the Ministry of Finance.

The law establishes the internationally accepted standards in Georgia, accounting, manufacturing, financial reporting, management reporting, and in the law of the State in respect of payments made on the preparation and submission of reporting, professional certification audit (services) c To give effect to and the quality assurance, the areas of the state supervision and the imposition of legal basis.

The goal of this law is to promote financial transparency and economic growth by approaching the requirements of the subjects and the relevant EU directives regulating the audit.

Accounting and financial statements are regulated by this Law and other normative acts of Georgia. Accounting and financial reporting must comply with international standards of accounting and financial reporting.

Accounting and Financial Reporting Standards consist of:

- a) International Financial Reporting Standards (IFRS);
- b) International Financial Reporting Standards for Small and *Medium-sized* Enterprises (IFRS for SMEs);
- c) Financial reporting standards for the fourth category enterprises;
- d) From financial reporting standards for non-entrepreneurial (non-commercial) legal entities.

International Financial Reporting Standards (IFRS) is the complete standards adopted and issued by the International Accounting Standards Board (IASB) or its assigning body, which include:

- a) International Financial Reporting Standards;
- b) International accounting standards;
- c) Interpretations made by the International Council for Financial Statements (IFRIC) or the Standing Committee on Interpretations (SIC).

IFRS for SMEs is the International Standards of Financial Reporting (IFRS for SMEs) approved by IASB or its assigning body for second and third categories of enterprises.

The Financial Reporting Standards for Financial Institutions for Non-Commercial (Non-Commercial) Legal Entities shall be set up by the accounting, reporting and audit supervision service for the fourth category of enterprises.

At present, the process of introduction of international standard of financial reporting of small and medium enterprises and standard of reporting of fourth category enterprises is active in Georgia. The situation of small and medium enterprises has a substantial impact on the improvement of the business environment, which significantly determines the country's economic growth pace, structure and gross domestic product.

In order to utilize accounting and financial reporting standards, subjects are classified according to the size categories, which are regulated by the above-mentioned law. The same law was defined by the size categories of enterprises and the responsibility of each of them to prepare and submit financial reporting.

Enterprise Categories	Assets (Gel)	Income (Gel)	The average annual number of employees	Preparation Reporting	Mandatory audits
<b>I Category</b>	> 50 000 000	> 100 000 000	>250	IFRS	subject to
<b>II Category</b>	< 50 000 000	<100 000 000	< 250	IFRS for SMEs	subject to
<b>III Category</b>	<10 000 000	< 20 000 000	< 50	IFRS for SMEs	Not subject to

IV Category	< 1 000 000	<2 000 000	<10	National standard	Not subject to
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In particular, according to the size categories the enterprises are classified into 4 categories. Each of them must satisfy the following conditions (See Table):

The criteria of enterprise size categories and requirements for the reporting and presentation of mandatory audit

**Source:** Georgian Law „Accounting, Reporting and Audit About “. Kutaisi. 08.06.2016

**Note:** Each category enterprise has to satisfy at least two criteria from three criteria at the end of the reporting period.

Enterprise prepares financial reporting at least once a year.

The financial reporting compiled by the subject must be complete, correct and fair. It should reflect the financial position of the entity, the results of the activity, the cash and capital movement and the explanatory notes for the period. The information in the financial reporting shall be in compliance with the fundamental qualitative characteristics defined by the International Financial Reporting Standards.

Entity (other than a non-profit legal person) is entitled to the statutory financial reporting, management reporting, and reporting to the state of payments made in cases prescribed by law with the audit report, immediately, but no later than the end of the reporting period to the next on Oct 1 Bree, submit to the established procedure., which is directly related to the agreement with Article 317, Parties shall aim at, in the fields of sharing information and professional experience, as existing systems and, as well as the new developments. In exchange, the Parties will seek to provide effective exchange of information between the registry of business companies of EU member states and the national registry of companies of Georgia ". [2. Chapter 6, Article 317].

In turn, the Supervision Service is obliged to submit reports and audit reports submitted by subjects, except for the fourth category of enterprises, to publish them within a month after their submission. The DP is obliged to publish the reports on their own website or print edition.

The procedure for submitting financial reporting simplified by the third category enterprise shall be drawn up by the Supervision Service, in line with the requirements of the relevant EU directives.

In addition to financial statements, economic subjects, namely publicly interested persons and enterprises of the first and second categories shall prepare and submit to the job report. The rules for preparation and submission of management reports are based on the requirements of the relevant EU directives, accounting for accounting, reporting and audit supervision service.

Reporting of payments to the State – The public stakeholder and the first category enterprise whose activities include entrails of the earth (including oil and gas extraction) or the production of timber in natural origin forests is obliged to prepare and submit annually reports about the payments made to the State.

## CONCLUSION

The EU-Georgia Association Agenda, EU Directives and Georgia-EU Deep and Comprehensive Free Trade Agreement (DCFTA) has been implementing certain reforms in accounting, reporting and auditing issues. The article deals with the challenges and innovations aimed at improving the presentation of financial statements.

In order to improve financial reporting in Georgia, along with partner organizations, serious work is underway. In particular, the Ministry of Finance accounting, reporting and audit supervision department, the World Bank, the EU and the reform of joint work aimed at raising academic and professional education, accounting and reporting of the main challenges, the current situation and trends , In the field of innovation and development in the resolution. Today, it is never as urgent as the agenda is on the rise of financial transparency and financial access to financial subjects, accounting for accounting and auditing professions that are fundamental to the country's economy and business development.

Enhanced cooperation between the EU and Georgia will facilitate the improvement of administrative and regulatory framework of EU and Georgian businesses, which function within the EU and Georgia, and rely on the policy of EU industrial and small and medium enterprises, taking into account the universally recognized principles and practices in this field.

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## COMMUNICATION MARKET ISSUES AND INNOVATIONS IN GEORGIA

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### ABSTRACT

In the last half of the twentieth century the world's governments were faced with plenty of issues and challenges. The government's role is especially important in post-soviet countries and introducing innovations in public administration must have a number of positive results. The Georgian government has a lot of connected long-term purposes which identify normal living standards of their citizens and the position of the country in the international arena.

Effective functioning of the market is the main precondition for consumer welfare, therefore, the existence of incomplete competition markets, which make competition limited, are unbiased. Sometimes oligopolistic firms reach agreement and produce socially ineffective volumes and accordingly they hinder consumers' well-being.

The structure of the communication markets plays a decisive role in the development of any country. In particular, if the government is able to increase competition in the market, the prices will be reduced, stimulating innovations and communication services will become available to a wider circle of consumers. (Jamison, 2009).

According to the fact that The Georgian Communications Market belongs to non-liberal sectors and, therefore, is regulated by the ex-ante (pre) regulation of the sector regulates the independent regulatory authority of the National Communications Commission, the effectiveness of regulation and relationship between regulation type and innovations in sector is highly interesting.

**Keywords:** Innovations, competition, communication, industry

### INTRODUCTION

Effective functioning of the market is the main precondition for consumer welfare, therefore, the existence of incomplete competition markets, which make competition limited, are unbiased. Sometimes oligopolistic firms reach agreement and produce socially ineffective volumes and accordingly they hinder consumers' well-being.

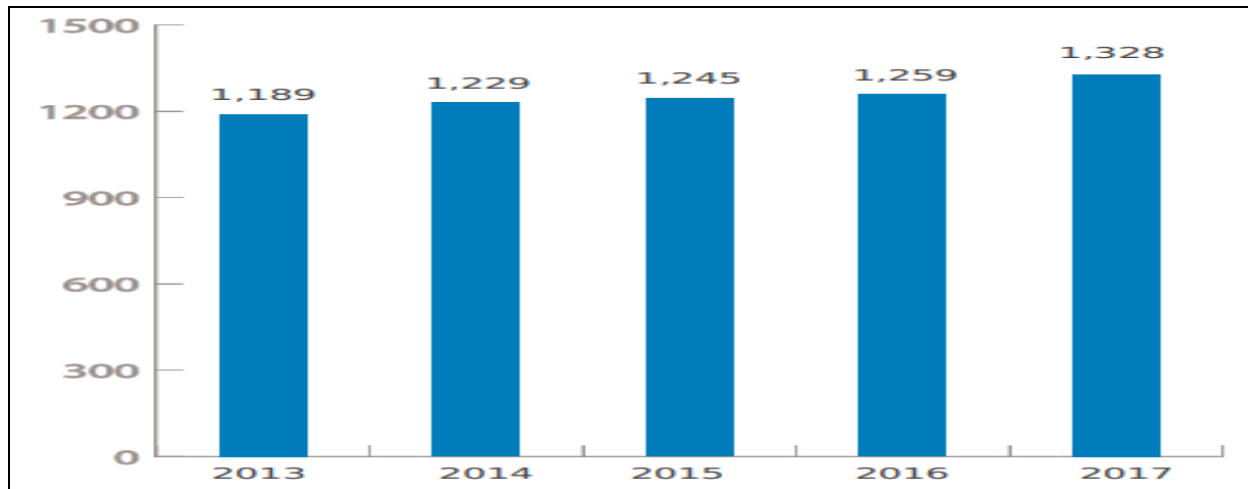
The structure of the communication markets plays a decisive role in the development of any country. In particular, if the government is able to increase competition in the market, the prices will be reduced, stimulating innovations and communication services will become available to a wider circle of consumers. (Jamison, 2009).

The communications industry is one of the most important economic sectors in both developed and transitional economies. Now it is considered as a stimulating factor and its role is evident.

The Georgian Communications Market belongs to non-liberal sectors and, therefore, regulated by the ex-ante (pre) regulation of the sector regulates the independent regulatory authority of the National Communications Commission.

The sector consists of mobile services, fixed telephone services, fixed broadband services (Internet) and television markets. The large companies operate in the sector that provide customers with diversified products. That is, the same company is a mobile operator, internet-provider, supplier of home and television.

According to the official data of GNCC the sector incomes are enough high:



As a result of the recent developments in the sectors of the communism, the number of suppliers has decreased in each sector of the sector and consequently reduced competition, which increases the ability of cartel transactions. Each player has almost identical suggestions for the user. Although the names of the packages and services offered by the three companies listed above differ from each other, in terms of consumers' expenses and benefits, it can be said that the standard product is delivered on the market.

As noted above, the communications sector belongs to regulated sectors and within the framework of the legislation, the GNCC is accountable to each player in the market. Although the Law of Georgia on Electronic Communications, the market players themselves have access to their own network elements and electronic communications service tariffs, but companies with significant market power are subject to tariff regulation and the upper and lower thresholds of the tariffs. Therefore, it can be said that the legislation on price control allowance provides, however, the market for the various studies suggest that the communications sector of all the company's pricing dynamics dramatically similar - there is substantial parallelism, as a variety of the company's established prices between these price changes time. Leading companies determine tariffs and product quality.

### Body part

If we decide to study Internet and Mobile operator markets and make analysis according to the number of consumers, we will find out that that we have Monopolistic company on the market of Mobile Operators: "Magticom" and company "Silk Net" on the market of Internet providers.

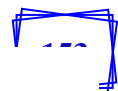
First of all we need to make the analysis of the market of internet providers. We can notice that there are 4 main players on the market: "Silk Net", "Magticom", "Akhali Khselebi" and "CGC".

Obviously, as of 2018, there are two leading companies in the market of the internet providers. These include: MagtiCom and Silknet. As we can see, MagtiCom's market power has increased since the second half of 2016, after the market's powerful player merged with Caucasus Online MagtiCom.

It is noteworthy that if we analyze the latest trends in the telecom market, we find that it is quite actively merging market players and thus decreasing the number of suppliers presented in the market, which in turn leads to a decrease in competition.

The trend of unification of mobile and fixed market players continued in the following way. The Commission gave consent to MagtiCom to buy 100% of Delta Com 's shares, and in case of their aggregation, the company was given consent only in part of the retail segment. Within the mentioned transaction, the Commission also agreed to merge Delta Comcom with Delta-NET and A-NET and to purchase the operating assets required for MagtiCom LLC Delta Commerce's retail customer service.

It should also be noted that two companies with the above-mentioned major market power companies have a significant impact on the suppliers as well as users. This opinion is based on the fact that small and medium telecommunication companies have filed 4 complaints to the GNCC against Magti and Silknet, but no specific response was made to the GNCC. The reason for filing complaints is that the concrete regions and cities in the leading companies offer consumers inadequately low tariffs that are susceptible to dumping pricing. However, according to the official statement of the Commission, there is no proper methodology that allows identification of the fact of dumping price factor. The overwhelming majority of the world's developed countries are fighting to defend competition and restrict market





competitiveness, but the fight is rarely effective because identifying these powerful formations is associated with a lot of difficulties.

The study of Georgian reality and the structural analysis of the communications market is particularly interesting, since taking into consideration the main goals and priorities of the country, promotion and protection of competition is one of the main preconditions for Georgia's economic prosperity. As noted in the socio-economic development strategy of Georgia, today it remains a problem that ensures free competition in the market. International assessments also indicate this. Despite the fact that the indicators of the competition have improved in comparison with the same period of previous years, the problems related to competition issues are still relevant.

The market leader of mobile operators is Magticom, which has the highest number of customers in all three years. For the period shown on the diagram, the market is 4 main players.

Two giant companies Geocell and Silk Net have been unified on the basis of preliminary consent from the Georgian National Communications Commission. As a result of this transaction, two mobile firms will be presented on the mobile operators market that offer customers online, mobile and TV services simultaneously. As a result, 74% of mobile subscribers, 77% of the internet market and 83% of TV service "Magticom" and "Silknet" will be compromised.

A considerable part of the experts think that the union will significantly hurt both the telecommunication market as well as the majority of Georgian population, as the market is actually significantly restricted to the market and only two companies, Magticom and Silknet, remain. Beeline will be the only competitor of the market, which operates only on mobile operators market and owns a 25% share. It is hardly expected that Beeline will be able to compete for two powerful companies and it is possible to assume that in the nearest future the company Vioni Georgia will decide to leave the market for Georgian mobile operators. The reduction of competition from the market, in the first place, will hurt users and put the threat to cartel transactions on the market.

The largest transaction in the history of Georgia is created by a new dominant company in the telecommunications market. As a result, in three major markets: mobile service, Internet and cable TV will have three large players, two of which will control the market  $\frac{3}{4}$ .

Particularly interesting is how this merger is reflected in the market and what resources are available to the third operator of the market, Beeline, in order to compete with the two biggest companies, Silknet and Magticom, a telecoms market, As well as on TV and Internet providers' markets.

It is noteworthy that the Chairman of the Georgian National Communications Commission (GNCC) urged the "Beeline" to activate investments and enter into a fixed market after merging "Silknet" - "Geocell".

According to experts in the field, there is no specific change in the market yet, but it is expected that certain negative consequences of this transaction. When another player disappears on the market, "Magticom" and "Silknet" share market power, and "Beeline" has no resources to increase its market share through any other company, as the relatively large suppliers "Silknet" and "Magticom" swallowed "and only small providers remain on the market.

According to experts, if Beeline is on the Georgian market, it will not be able to compete. The "Magticom" and "Silknet" will try to offer customers a unified package.

As we have mentioned, the main economic impact of competition level is a negative impact on consumers' well-being. In order to verify this hypothesis, we have conducted a public opinion survey on mobile operators market. We researched 300 users by internet research method and analyzed the prospect of consumers' welfare from surveying consumer opinions and attitudes on the mobile operators market.

As it turned out, 73% of respondents were Magticom subscribers, 16% Geocell and 11% of Beeline mobile services.

Survey of consumers' satisfaction in mobile operators shows that the market of mobile operators is not characteristic of the main market of the competitive market: alternatives exist. Each player of the market provides customers with similar or identical packages and services, which are absolutely adequate considering the level of competition on the market. In spite of the fact that the operator chooses the operator according to the tariffs, its satisfaction level is low on the proposed tariffs.

Consumer expenditure on mobile service is quite high on monthly basis, taking into consideration the average monthly income per capita in our country. Despite the fact that the mobile operator market is permanently grown as revenue and the number of subscribers, no access to packages is available and diversification of insurable services.

It should be noted here that the above research reveals that market players do not have any significant competitive advantages over each other, which still indicates the lack of alternatives to customers.

According to the review "regulatory reform and innovation" made by organization for economic cooperation and development, there are several general conclusions on how to improve the positive regulatory effects on innovation without jeopardising the original regulatory objectives:

Understand regulation/technology linkages. The regulatory process – whether in the economic, social or administrative spheres – must be ever vigilant to the effects of technical change.

Introduce competition. In all economic sectors, a certain degree of competition among firms is essential to the innovative process.

Streamline regulations. In the interest of economic efficiency and innovation, regulatory reform should seek to remove duplicative, onerous and inefficient regulations, particularly to aid small and medium-sized enterprises.

Use technology-driving approaches. Maximum use should be made of regulatory approaches or alternatives which are technology-friendly, such as economic instruments, voluntary agreements and performance rather than design standards. Harmonize internationally. Countries should pursue greater compatibility among their regulations to remove uncertainties, inefficiencies and market barriers which can slow innovation.

We can easily find that there is not enough competition on Georgian communication market for introducing innovations.

## CONCLUSION

Based on the above mentioned, the survey shows that the existing level of competition is negatively impacted on the prosperity of the user and, consequently, the number of players on the market will be reduced, the worse the situation. Therefore, the main goal of the regulator is to stimulate the entry of new players into the market.

The efficient functioning of the market is the main precondition for consumers' well-being, therefore, the existence of imperfect competition markets, which is conditioned by competition limits, is unbiased. The oligopoly comprises operating in agreement with the violation of the basic principles of market economy affect the volume of socially ineffective production of consumers who value the product / service at the expense of production costs but can not afford it.

There is not appropriate level of competition in the market of communication in order to provide necessary innovations

Based on the above mentioned relationship between competition level on market and innovations we can say that we do not have enough number of suppliers for making industry more innovative.

Georgian electronic communications sector is high quality concentration and the oligopoly structure is formed;

Based on the above discussion, we can say that the entire Georgian telecommunications sector is characterized by the oligopolistic structure. Barriers to market entry and market power are concentrated in the hands of market leader companies.

Mobile operators do not have customers in the market.

Survey of consumers' satisfaction in mobile operators shows that the market of mobile operators is not characteristic of the main market of the competitive market: alternatives exist.

Based on the results of market research on mobile operators above, it can be explicitly stated that customers do not have the option to choose between different options and services, which is a direct result of the lack of competition level.

Higher monthly consumer expenditure on mobile service purchase.

Taking into consideration the average monthly income per capita in our country, the results of the survey indicate that the population of the country is going to address a substantial part of the mobile service.

In the field of Georgian electronic communications, the recent merger is a threat to the formation of a duopoly structure in the sector.

Recently, the market power of two companies Magticom and Silk Net have increased significantly in the field of electronic communications. "Magticom" is the market leader of mobile operators and "Silk Net" is the leader of the Internet Producers market, but both companies share market power with the market leader on the above mentioned segments. Consequently, even though there is no duplicate market structure on any particular segment of the telecoms induction, in case of development of current trends, a significant threat to the formation of duopoly structure in the Georgian telecommunications industry is being created.

The threat of cartel deal in the telecommunications sector is created.

Obviously, from the above-priced pricing models, "Silk Net" and "MagtiCom" will be the most lucrative cartels. If the two companies reach the agreement they will receive monopoly winnings, which will be reflected negatively on the welfare of society.

Market power of leader companies in mobile operators and inter-state providers creates a dangers of damping pricing

In the National Communications Commission, small internet providers have included numerous complaints about marketable market leader companies in some regions of Georgia. Taking into consideration that the Commission does not have an appropriate methodology to study this issue, the question remains unclear. And this is the long-term perspective of the small companies out of the market.

It is necessary to carry out the stimulating measures for the introduction of new suppliers on each segment of the sector by the Georgian National Communications Commission.

One of the most important powers of the regulatory authority is the protection and promotion of competition in electronic communications. Therefore, it is possible to stimulate the entry of new players into the market, considering the restriction of abuse of the existing market power of the market players.

Acting legislation and existing leverage is not enough;

Obviously, the current legislation and methodology can not prevent the use of competition limitation and the abuse of advantages by companies with vigorous market power in the market. For example, the methodological shortcomings are

to leave unanswered statements about the dumping proposing when such action is directly proportionate to the breach of competition on competition and expel competitors.

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## ASSESSMENT OF EQUIVALENT EFFECTIVE TEMPERATURE CHANGES IN VARIOUS METEOROLOGICAL CONDITIONS BASED ON COMPUTATIONAL EXPERIMENTS

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### ABSTRACT

In modern times, the assessment of the human body's condition depends on climatic factors is even more active against the backdrop of global climate changes. In this aspect, the paper provides a literature review of the research and methods used in this field, and a widely used computational experiment approach was used in scientific research to estimate the change of Equivalent Effective Temperature in various meteorological conditions.

**Keywords:** comfort index, human body, climatic factors, complex biological indicators, meteorological conditions, equivalent-effective temperature, calculation experiment.

### INTRODUCTION

In modern times, numerous methods of assessing the state of the human body, which depends on climatic factors, have been developed (Andreev, 2010, Andreev, 2012; Ivanov and Ivanova, 2011; WHO, 2003; Izmerov, Revich and Korenberg 2005; Methodical recommendations, 2012, WHO, 2005; Platonov, 2006; Revich, Shaposhnikov, Galkin and etc. 2005). Some of them are based on "complex bioclimate indicators" (Andreev, 2010, Andreev, 2012; Revich, Shaposhnikov, Galkin and etc. 2005). It has already been established that the most important of the environmental factors that affect people are the factors that determine their thermal state. The heating condition of people depends significantly on the microclimate parameters that surround it at the same time. It is also established that these parameters do not allow people to quantify the heating situation. Therefore, the temperature of the human body has been developed so that they can express and quantitatively calculate the corresponding physiological reactions of the human body.

It is known that the comfort temperature range of the human body is very narrow in contrast to the natural processes of air temperature. But the fact that the body temperature goes beyond the 26-40° range leads to very dangerous changes. Sweating is the main means of cooling the body in conditions of high air temperature and humidity. And when the temperature reaches 32°, the loss of heat by this rule goes down to zero. The air humidity together with the air temperature has a great effect on the human body. For example, in the same temperature conditions, the humiditonal air is "warmer" than dry air. The strong wind exerts pressure on the surface cells of the human skin, which leads to deplorable fatigue, and in winter to a decrease in the temperature of the body. At the same time, in extreme weather, the number of neurologic accidents and road accidents is increasing (Andreev, 2010, Andreev, 2012; Revich, Shaposhnikov, Galkin and etc. 2005).

"Complex bio-climatic indicators" are the indicators of air temperature, and humidity, wind speed, atmospheric pressure, cloudiness, etc. functions are. These indicators or indexes determine the ranges of meteorology faktors in such a way that a person feels comfortable (comfortable) or uncomfortable (uncomfortable).

Depending on the totality of the meteorological elements included in the biometeorological indices, they are conditionally temperature-humidity, temperature-wind, temperature-humidity-wind, etc. it can be divided into indices. To the issues of justification and calculation of bio-climatic indices used in world practice (A.C.Eyyubov, 1997), It is widely covered in N.V.Kobysheva's, S.S. Andreyev's ((Andreev, 2010, Andreev, 2012) studies. For example, in S.S.Andreyev's research, the effective temperature of the air that is not in motion to themomaticity ratios of the bio-climate index, the index of discomfort developed in the United States and Japan, the temperature-wind index (cold stress index), the index of wind chill according to Saypl, the corrected index of wind-cold worked in Canada, the index of air hardness the air hardness coefficient of the index, according to informativity rates are given in points.

According to the data provided in (Andreev, 2010), the temperature-to-humidity index is a effective temperature according to A.Missenard, diskomfort according to Tom, diskomfort index processed in Japan, temperature-humidity-wind index A.Missenrad's human feelings of heat, V.I.Rosanov equivalent-effective temperature. Temperature-humidity-wind index considering solar radiation V.I.Rosanov's balance of heat balance of man, the radiation temperature-humidity-wind index of Q.B.sheleykhovsky can be attributed.

Along with these, the climate hardness index is widely used. These include the air hardness coefficient, the wind cooling index, the bio-climatic index of the hardness of meteorological conditions. At the same time, general indices of the

pathogenicity of weather conditions are also used. Of course, the advantages and disadvantages of the methods of calculating and evaluating these indices are relevant and detailed analysis is given in (Andreev, 2010). In the field of human ecology, the occurrence of discomfort as a result of excess heat or cold air, and in general, the degree of comfort of the climate is assessed by one or more biometeorological temperature indexes.

1) biologically active temperature-it is calculated depending on the air temperature, relative humidity and albedo of the human skin;

2) radiation-equivalent-effective temperature- is calculated depending on the air temperature, relative humidity, wind speed, intensity of solar radiation and albedo of the human skin;

3) equivalent effective temperature- is calculated depending on the air temperature, relative humidity and wind speed;

4) the heat balance of a man - is calculated depending on the salt and scattered solar radiation, the height of the sun at the zenith, the albedo of the non – pigmented skin, the thermal product of the human body;

5) the pathogenicity index of meteorology situation- is calculated using the air temperature and its pathogenicity index, the pathogenicity index of the daily change in temperature, the relative humidity of the mid-range, the speed of the mid-range of the wind and its pathogenicity index, the pathogenicity index of cloudiness;

6) the climatic potential of self – purification of the atmosphere- is calculated depending on the number of rainy days, relative humidity days more than 80%, precipitation days more than 0.5 mm, wind speed days more than 6 m/s.

It should be noted that the results of the first decades of research in this direction in the territory of the Republic of Azerbaijan have been presented in (Badalova, Safarov S., Safarov A., Islamova R., 2014). Here, for the mountainous areas of the Greater Caucasus, the temperature and relative humidity of the air for 1971-2010 and the equivalent-effective temperature dependent on wind speed were calculated, on the basis of which the degree of comfort of the climate was assessed. It can be noted that in our country studies are continued in this request (Badalova, Safarov S., Safarov A., Islamova R., 2014; Ramazanov, 2015).

Taking into account the urgency of the issue, a brief explanation of climate comfort assessment methods [15] is given below.

**1) Temperature- humidity indicators.** These include the following indexes:

**1.1) Effective temperature (ET, °C)** (according to A.Missenard) is characterizes the temperature of dry air saturated with water vapor. it is calculated for all seasons of the year and is used for classification and regionalization of bioclimate classification. Calculated as follows:

$$ET = t - 0.4 \cdot (t - 10) \cdot \left(1 - \frac{f}{100}\right), \quad (1)$$

were,  $t$  is temperature of the air, °C;  $f$  – the relative humidity of the air, in %.

**1.2) DI** (estimated as a point) is discomfort index or temperature-humidity index of temperature-rotobility (according to Tom), developed in the US. It is an empirical indicator and is an analogue of the equivalent temperature in the formula in the absence of wind (1). Such is calculated:

$$DI = 0.4 \cdot (t + t_{bulb}) + 4.8, \quad (2)$$

where  $t_{bulb}$  is the temperature according to the bulb thermometer, °C.

**1.3) DY** (estimated as a point) is discomfort index. According to this index, the normal temperature sense was taken at  $60 \leq DY \leq 70$  poynt.. It was developed in Japan and calculated as follows:

$$DY = 0.99 \cdot t + 0.36 \cdot t_d + 41.5, \quad (3)$$

where  $t_d$  is dew point.

**2) The temperature-humidity-wind indicators (for shaded areas).** These include the following indexes:

**2.1) Equivalent Effective Temperature (EET) (°C)** is an indicator of a person's sense of heat due to the Missenard. It characterizes the heat-feeling of a person and used of . Bioiqlim is used for global classification of bioclimatological indicator:

$$EET = 37 - \frac{37 - t}{0.68 - 0.0014 \cdot f + \frac{1}{1.76 + 1.4 \cdot v^{0.75}}} - 0.29 \cdot t \cdot \left(1 - \frac{f}{100}\right), \quad (4)$$

where  $t$  is wind temperature;  $f$  is the relative humidity air in %;  $T = 37 - t$  difference between human body and air temperature; where  $V$  is the wind speed at 10 m of height (at the level of the meteorological station), in m/s (it was hit 2/3 to bring the wind speed from the standard height to 1.5 m).

**2.2) Equivalent Effective Temperature (EET) (°C)** – proposed by russian researcher V.I.Rusanov. It's calculated the

1-ci Beynəlxalq Elmi-Praktik Konfrans:

Müasir İnformasiya, Ölçmə və İdarəetmə Sistemləri: Problemlər və Perspektivlər (MİÖİS-2019)



comfort ( $17.3 \leq EET \leq 20.7^\circ\text{C}$ ) condition for a man without a coat:

$$EET = t \cdot [1 - 0.003 \cdot (100 - f)] - 0.385 \cdot v^{0.59} \cdot [(36.6 - t) + 0.662 \cdot (v - 1)] + [(0.0015 \cdot v + 0.008) \cdot (36.6 - t) - 0.0167] \cdot (10 - f), \quad (5)$$

**2.3) Normal Equivalent Effective Temperature (EET) ( $^\circ\text{C}$ )** - proposed by russian researcher I.V. Butyeva. Comfort zone is in the  $17.2\text{--}21.7^\circ\text{C}$  range. The temperature at which people feel comfortable is  $18^\circ\text{C}$ , calculated as follows:

$$NEET = 0.8 \cdot EET + 0.7^\circ\text{C} \quad (6)$$

**3) The temperature-humidity-wind indicators taking into account solar radiation.** These include the following indexes:

**3.1)  $Q_s$  ( $\text{kW/m}^2$ )** - price of heating sense is the the body heat balance, according to V.I. Rosanov. This index is used to construct a model of a person's thermal state and allows to obyektivt estimate the degree of functional tension of a person's thermoregulation system. The calculation formula is as follows:

$$Q_s = [(ct \cdot g \cdot h / \pi) \cdot S + 0.5 \cdot D] \cdot (1 - \alpha) + M + 0.004 \cdot EET - 0.98, \quad (7)$$

where  $S$  is the direct solar radiation,  $\text{kW/m}^2$ ;  $D$ -scattered solar radiation,  $\text{kWt/m}^2$ ;  $h$  – the degree of height of the Sun at the zenith,  $m$ -the albedo of the human skin;  $M$ -the heat product of man,  $\text{kWt/m}^2$ .

The basis of the empirical formula (7) is the heat balance equation of the human body. On the basis of V.I Rosanov's air moment classification (taking into account the thermoregulatory reactions of man), calculated  $Q_s$  prices are used, labor regimes and climate therapy are prescribed for different classes of air moments of hot and cold periods. The human feeling of heat is classified as follows according to  $Q_s$ :  $Q_s > 10$ - very heat;  $0.10 < Q_s < -0.05$ -heat;  $-0.06 < Q_s < -0.30$ -comfort;  $-0.31 < Q_s < -0.65$ -cool;  $-0.66 < Q_s < -0.98$ -cold;  $Q_s < -0.99$ -very cold.

**3.2) Radiation Equivalent Effective Temperature (REET), ( $^\circ\text{C}$ ).** Meteorology characterizes the feeling of heat of a man in clothes, taking into account the complex effect of factors and solar radiation. Calculated by means of the following formula for the warm period of the year:

$$REET = 125 \cdot \lg |1 + 0.02 \cdot t + 0.0001 \cdot (t - 8) \cdot (f - 60) - 0.0045 \cdot (33 - t) \cdot \sqrt{v} + 0.129 \cdot \beta|, \quad (8)$$

where,  $\beta = Q(1 - \alpha)$  is gained solar radiation by the human body;  $Q$  is total solar radiation;  $\alpha$  - taking into account a pigmentation, the albedo of the human skin (0.11 for the pigmented skin, 0.28 for the non-pigmented skin).

The optimal ranges of the REET are as follows:  $17\text{--}21^\circ\text{C}$  –southern regions;  $13\text{--}18^\circ\text{C}$  –temperate latitude regions;  $10\text{--}18^\circ\text{C}$  –northern regions. The optimal valuation of REET is  $18^\circ\text{C}$ .

At the same time, this method allows you to determine the degree of heat yuklanmasi to the body in hot climatic conditions.

**Methodology.** In order to assess Equivalent Effective Eemperature in various meteorological conditions, a computational experiment approach widely used in scientific research was used [3]. For this purpose, calculations were made on the basis of various vaules of the air temperature, relative humidity and wind speed changes.

**Result.** For the computational experiments (Badalova, Safarov, Ramazanov, 2018), the following calculation variants were used (see table 1).

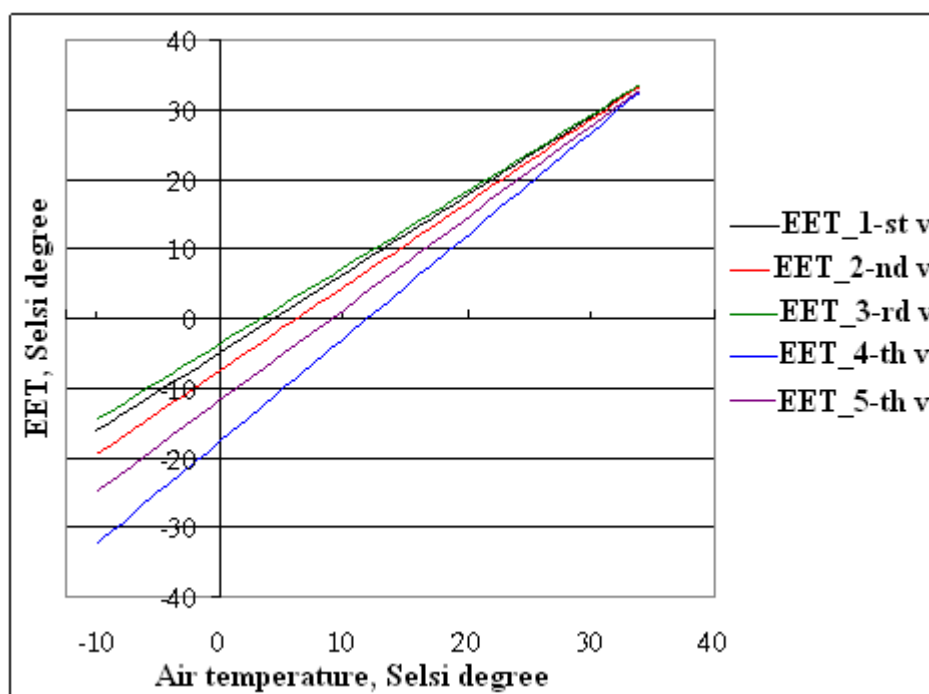
Table 1. The variants of calculations of Equivalent Effective Temperature depending on on the air temperature ( $t$ ), relative humidity ( $f$ ) and wind speed ( $v$ ).

Variants	The values of meteorological parametres		
	$t, ^\circ\text{C}$	$v, \text{m/s}$	$f, \%$
EET-1	10....+34	2	56
EET-2	-10....+34	2	95
EET-3	-10....+34	2	35
EET-5	-10....+34	10	35
EET-6	22	2	35....100
EET-7	22	10	35....100



EET-8	22	20	35....100
EET-9	22	0....30	56

As can be seen from Table 1, in the 1-5th calculation variants, it is considered how the air temperature at certain fixed values of wind speed and relative humidity of the air will change from  $-10^{\circ}\text{C}$  to  $+34^{\circ}\text{C}$  every  $5^{\circ}\text{C}$ . The obtained results are given in Figure 1.



**Figure 1. Equivalent effective temperature change depending on the air temperature**

In the 1st variant ( $v=2\text{m/s}$ ;  $f=56\%$ ), the air temperature increased from  $-10^{\circ}\text{C}$  to  $+34^{\circ}\text{C}$ , the value of EET increased from  $-16.0^{\circ}\text{C}$  to  $+33.5^{\circ}\text{C}$ , that is, if the air temperature amplitude was  $44^{\circ}\text{C}$ , then the amplitude of EET ( $33.5 - (-16.0)$ ) was  $49.5^{\circ}\text{C}$ .

In the 2nd variant ( $v=2\text{m/s}$ ;  $f=95\%$ ), the value of EET increased from  $-19.4^{\circ}\text{C}$  to  $+33.4^{\circ}\text{C}$ , while the amplitude ( $33.4 - (-19.4)$ ) was  $52.8^{\circ}\text{C}$ .

In the 3rd variant ( $v=2\text{m/s}$ ;  $f=35\%$ ), the value of EET increased from  $-14.4^{\circ}\text{C}$  to  $+33.5^{\circ}\text{C}$ , while the amplitude ( $33.5 - (-14.4)$ ) was  $47.9^{\circ}\text{C}$ . A comparative analysis of the results obtained on all three options shows that at the same value of wind speed, the price of relative humidity of air exceeds the value of EET, not only in its decreasing values. These differences manifest themselves in the lower values of air temperatures. For example, EET's values were  $-19.9^{\circ}\text{C}$  in  $f=95\%$ ,  $-16.0^{\circ}\text{C}$  in  $f=56\%$ , and  $-14.4^{\circ}\text{C}$  in  $f=35\%$ , if the air temperature could be  $-10^{\circ}\text{C}$ . In the event that the air temperature could be  $+34.0^{\circ}\text{C}$ , the values of EET in all three variants were  $33.4-33.5^{\circ}\text{C}$ , which was very close to the air temperature. It seems that the impact of air humidity on EET at small values of wind speed is stronger at small values of air temperature.

In the 4th variant ( $v=10\text{m/s}$ ;  $f=95\%$ ), the value of EET increased from  $-22.2^{\circ}\text{C}$  to  $+32.6^{\circ}\text{C}$ , while the amplitude ( $32.6 - (-22.2)$ ) was  $54.8^{\circ}\text{C}$ .

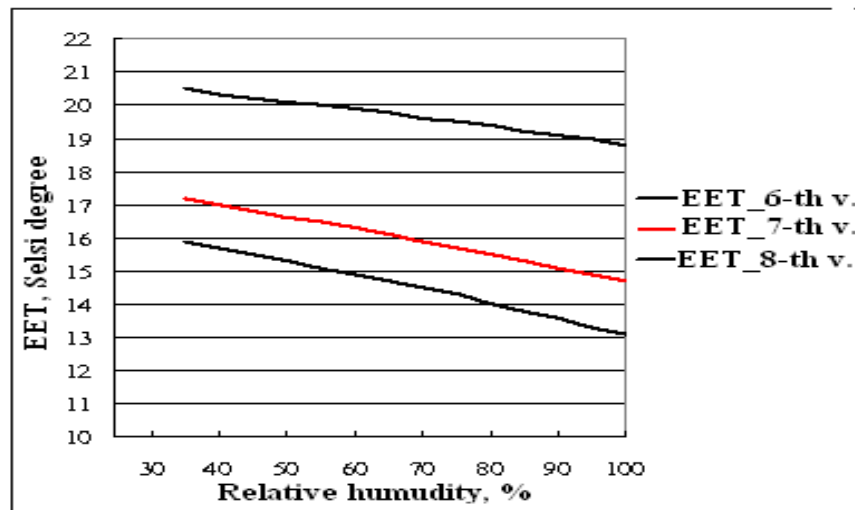
In the 5th variant ( $v=10\text{m/s}$ ;  $f=35\%$ ), the value of EET increased from  $-24.8^{\circ}\text{C}$  to  $+32.9^{\circ}\text{C}$ , while the amplitude ( $32.9 - (-24.8)$ ) was  $57.7^{\circ}\text{C}$ . From the results obtained here, it can be seen that in larger values of wind speed, the values of EET are even lower, and these differences manifest themselves more sharply at the lowest temperatures.

Depending on the relative humidity, 3 variants of EET changes (6-8 th variants) are considered (Table 1). In these variants, the air temperature was  $22^{\circ}\text{C}$ , in 3 cases of wind speed change ( $v=2\text{ m/s}$ ;  $10\text{ m/s}$ ;  $20\text{ m/s}$ ), the relative humidity was changed every 5% and the changing characteristics of EET in the range of 35-100% were considered. The obtained

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results are given in Figure 2.

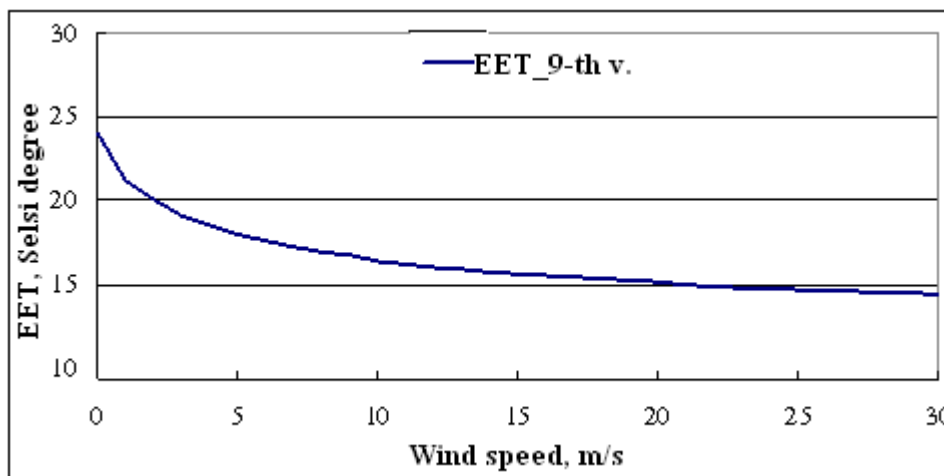


**Figure 2. Equivalent Effective Temperature changes, depending on the relative humidity**

In the 6th variant ( $t=22^{\circ}\text{C}$ ;  $v=2\text{m/s}$ ), the value of EET in excess of 35% to 100% in the case of decreased air temperature from  $20.5^{\circ}\text{C}$  to  $15.9^{\circ}\text{C}$ , in the 7th variant ( $t=22^{\circ}\text{C}$ ;  $v=10\text{m/s}$ ) from  $17.2^{\circ}\text{C}$  to  $14.7^{\circ}\text{C}$ , in the 8th variant ( $t=22^{\circ}\text{C}$ ;  $v=20\text{m/s}$ ) from  $15.9^{\circ}\text{C}$  to  $13.1^{\circ}\text{C}$ . As it seems, as the price of relative humidity increases in every 3 variants, the values of EET decrease, and the largest decrease occurs in small values of wind speed, and the smallest decrease occurs in large values of wind speed, that is, the effect of wind exceeds the effect of relative humidity of air. This can be seen more clearly from the results of the 9th and 10th variants.

There is considered one variant of the equivalent effective temperature change depending on wind speed (9th variant) (Table 1). In this variant, the relative humidity was 56%, in one case of a change in the temperature of the air ( $t=22^{\circ}\text{C}$ ), the characteristics of the change of EET in the range of 0-30 m/s with a change in the wind speed every 1 m/s were considered. The obtained results are given in Figure 3.

As can be seen from Figure 3, the values of EET ( $^{\circ}\text{C}$ ) was higher than the air temperature ( $24.0^{\circ}\text{C}$ ) when the wind speed was only 0 m/s, then the value of EET began to decrease as the wind speed increased and this decrease was of nonlinear nature. That is, more sharp reductions occur at lower values of wind speed ( $v=0-3\text{m/s}$ ). In case of 30 times decrease in wind speed, values of EET decreased by 1.5 times.



**Figure 3. Equivalent-effective temperature change depending on wind speed**

## CONCLUSION

In the article, various calculation options were proposed and practical calculations were made depending on the air temperature, relative humidity and wind speed to the Equivalent Effective Temperature to be calculated to conduct computational experiments. At the values prices of wind speed and relative humidity in different calculation options, it was considered how the EET will change when the air temperature changes from  $-10^{\circ}\text{C}$  to  $+34^{\circ}\text{C}$  every  $5^{\circ}\text{C}$ , and the results obtained were presented graphically. Depending on the relative humidity, three variants of EET changes were considered. In these variants, the air temperature was  $22^{\circ}\text{C}$ , in three cases of wind speed change ( $v=2\text{m/s}$ ;  $10\text{m/s}$ ;  $20\text{m/s}$ ), the relative humidity was changed every 5% and the change characteristics of EET were examined in the 35-100% range and intensive graphs were built on the obtained results. The prohibitions show that the value of EET ( $^{\circ}\text{C}$ ) exceeded the air temperature only in case of wind speed of  $24.0\text{ m/s}$ , and then the value of EET began to decrease as the wind speed increased and this decrease was of non-linear nature. That is, more drastic reductions occur at lower wind speed values ( $v=0-3\text{m/s}$ ), so if wind speed drops by 30 times, EET values have decreased by about 1.5 times.

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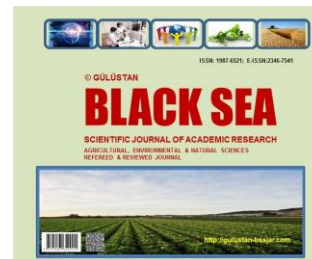
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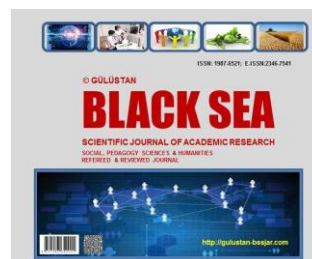
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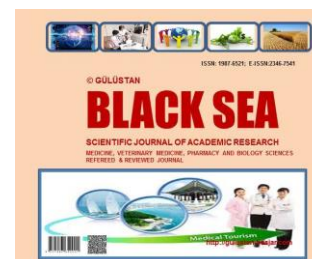
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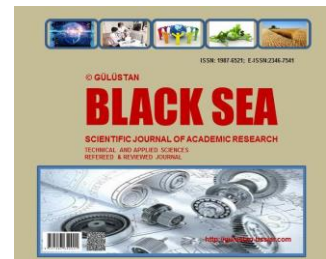
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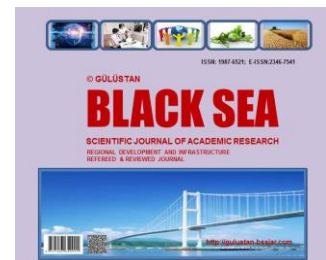
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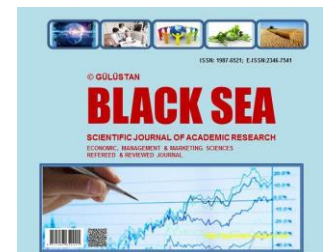
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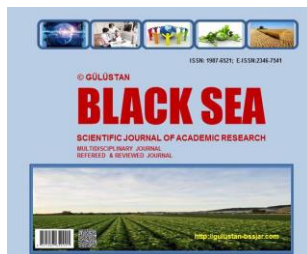


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The Caucasus Economic and Social Analysis Journal has ISSN, E-ISSN and UDC numbering:  
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**ISSN: 1987-6521; E-ISSN:2346-7541; DOI prefix: 10.36962**

©**Publisher:** LTD International Research, Education & Training Center. (UK, London),

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ISSN: 1987-6521; E-ISSN: 2346-7541, DOI prefix: 10.36962  
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